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Ocena częstości występowania i stopnia nasilenia objawów nietrzymania moczu w grupie dorosłych kobiet aktywnych fizycznie

The frequency and severity of urinary incontinence symptoms in the group of adult physically active women

Czy ćwiczenia ekscentryczne mogą zredukować rozejście mięśnia prostego brzucha?

Can eccentric exercises reduce diastasis recti?

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Effect of windmill arm exercises on junior swimmers' 50-meter freestyle speed in swimming

Wpływ ćwiczeń ramion 'wiatrak' na prędkość pływania na 50 metrów stylem dowolnym wśród młodych pływaków

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Abstract

The purpose of this study is to determine the effect of windmill arm exercises on 50-meter freestyle swimming speed. Methods. This research used an experimental method with a one-group pre-test-post-test research design. Sampling used a total sampling technique with 45 junior swimmers as participants. The data collection method used the 50-meter freestyle swimming test in both the pre-test and post-test. This research used the t-test for analysis. Results. Based on the results of this research, the calculated t-value is 20.364. This t-value (20.364) is compared to the critical value of t (2.000) at a significance level of α = 0.05 with a degree of freedom df = n − 1 = 44. Thus, tht_hth (20.364) > ttt_ttt (2.000), and based on the table for α = 0.05, a significance level of 0.05 is obtained. This indicates a significant effect on improving the 50-meter freestyle swimming speed of the sample group. Conclusions. Thus, the null hypothesis (H0) is rejected, and the alternative hypothesis (Ha) is accepted. Findings. The alternative hypothesis (Ha) states that windmill arm exercises affect 50-meter freestyle swimming speed in junior swimmers.

Key words

windmill arm, freestyle swimming, junior swimmer

Streszczenie

Celem tego badania jest określenie wpływu ćwiczeń ramion 'wiatrak' na prędkość pływania na 50 metrów stylem dowolnym. Metody. Badanie wykorzystało metodę eksperymentalną z jednogrupowym projektem badawczym przed-testem i po-teście. Próbkowanie wykorzystało technikę całkowitego próbkowania z udziałem 45 młodych pływaków. Metodę zbierania danych stanowił test pływania na 50 metrów stylem dowolnym w teście przed i po teście. W badaniu użyto testu t do analizy. Wyniki. Na podstawie wyników badań obliczona wartość t wynosi 20,364. Ta wartość t (20,364) jest porównywana z wartością krytyczną t (2,000) przy poziomie istotności α = 0,05 oraz stopniu swobody df = n − 1 = 44. Zatem tht_hth (20,364) > ttt_ttt (2,000), a na podstawie tabeli dla α = 0,05 uzyskuje się poziom istotności 0,05. Wskazuje to na istotny wpływ na poprawę prędkości pływania na 50 metrów stylem dowolnym w grupie próbnej. Wnioski. Zatem hipoteza zerowa (H0) jest odrzucana, a hipoteza alternatywna (Ha) przyjęta. Wyniki. Hipoteza alternatywna (Ha) stwierdza, że ćwiczenia ramion 'wiatrak' wpływają na prędkość pływania na 50 metrów stylem dowolnym wśród młodych pływaków.

Słowa kluczowe

ćwiczenia ramion 'wiatrak', pływanie stylem dowolnym, młody pływak

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Introduction

Swimming is a sport that emphasizes an athlete's speed in competitions. The swimming styles that are contested are freestyle, backstroke, breaststroke, and butterfly stroke. The swimmer who wins the swimming competition is the swimmer who completes the fastest time in the distance being competed. The winner of the preliminary round advances to the semifinal round, and the winner of the semifinal round advances to the final round [1]. Freestyle swimming is swimming with the chest position facing the surface of the water. Both arms are alternately moved far forward with a pedaling motion, while both legs are alternately whipped up and down [2]. In the book Swimming Fastest [3]. Swimming involves various physical components that are important to develop in order to achieve optimal performance. In long-distance races, such as 400 meters or 1500 meters, freestyle is the most common choice, as it allows the swimmer to maintain high speed over a long distance. Some of the main physical components that play a role in swimming are speed. Speed is a key factor in swimming, especially in short-distance races such as 50 meters or 100 meters. In swimming races, athletes need to reach the swimmer's maximum speed to beat their opponents [4]. Good and efficient swimming technique is very important to achieve optimal speed. Aspects such as pushing technique, arm movement, breathing coordination, and body rotation play a big role in increasing swimming speed [5]. Some common problems that junior swimming athletes may face in freestyle are imperfect technique. In the early stages, junior swimming athletes may experience difficulty mastering freestyle swimming techniques. Imperfect technique can hinder their ability to swim efficiently and quickly. Improper breathing or irregular or inappropriate breathing while swimming can be a problem. This can cause fatigue more quickly and affect the quality of swimming movements.

Speed is a key factor in swimming, especially in short-distance races such as 50 meters or 100 meters. In swimming races, athletes need to reach the swimmer's maximum speed to beat their opponents. Good and efficient swimming technique is very important to achieve optimal speed. Aspects such as pushing technique, arm movement, breathing coordination, and body rotation play a big role in increasing swimming speed [6]. Speed training will help to improve the efficiency of movement in water and hone technical skills. According to [7], speed determines factors in many sports. Speed has the ability to carry out similar movements in succession in the shortest possible time, or the ability to cover a distance in the shortest time. Junior swimmers swimming in freestyle can face some unique challenges and problems while developing skills and performance. Some common problems that junior swimming athletes can face in freestyle are less than perfect technique. In the early stages, junior swimming athletes may experience difficulty mastering freestyle swimming techniques. Imperfect technique can hinder their ability to swim efficiently and quickly improve breathing. On the other hand, irregular or inappropriate breathing during swimming may lead to difficulties. These key factors may cause fatigue and affect the quality of movement.

Windmill Arm

Lie on your stomach and kick your legs while moving your arms in a windmill motion. Freestyle swimming requires you to lie face-down, moving your arms and legs to propel yourself forward [8]

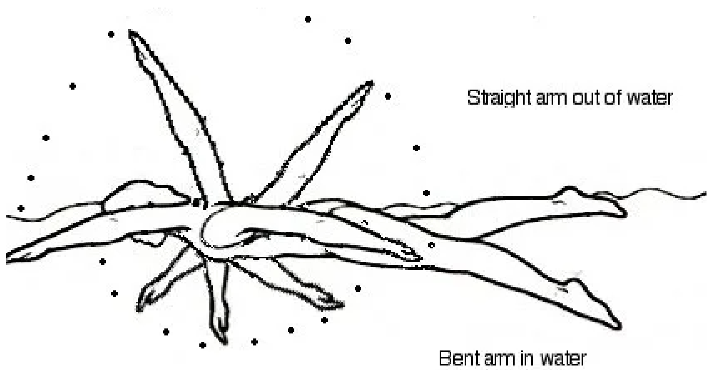

Figure 1. How to do a windmill arm

Windmill arm with big circle

The windmill arm big circle is an arm movement exercise. In this exercise, the swimmer will swing their hand like a windmill motion with large or perfect movements. This movement aims to maximize arm movement and push the water with optimal strength [9].

Figure 2. Windmill Arm with big circle

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Bubbles with Side Breathing (Right hand)

The bubbling technique helps swimmers breathe properly. When swimming, you inhale through your mouth when your face is above the water and exhale through your mouth or nose when your face is underwater. Beginners often panic during the underwater phase and struggle with proper exhalation [10].

Figure 3. Bubbles with side Breathing

One Pulling with Side Breathing (Right Hand)

In swimming, bilateral breathing means breathing in both sides during forward crawl movement. This usually results in breathing an odd number of strokes—for example, 3, 5, 7, etc. For many swimmers, bilateral breathing can be very useful for keeping the stroke balanced and helping to maintain a straight line throughout the swim [11]. In one-pulling with side breathing, the swimmer performs a windmill arm movement followed by taking a breath on the right side. However, it is only done on the right side. For this exercise, the focus should be taking the right breath only. This focuses on right-side breathing, as many swimmers predominantly breathe to one side.

Figure 4. One Puling with Side Breathing (right hand), One Puling with Bubbles (Left Hand).

One pulling with side breathing (right), one pulling bubbles (left)

This exercise aims to help swimmers breathe effectively on both the right and left sides.

Figure 5. 3 Hand Pulling with Side Breathing (Right), 3 Hand Puling Side Breathing (Left)

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3 Hand pulling with side breathing (right), 3 hand pulling side breathing (left)
Bilateral breathing helps swimmers maintain an even stroke and swim in a straight line. Additionally, the swimmers who are most likely to experience shoulder and neck injuries are the ones who only breathe to one side – a feature of poorer posture and a reliance on one side of the body doing most of the work [12]

The 3-hand pulling with side breathing exercise closely resembles freestyle swimming movements. This exercise is done by doing the windmill arm movement 3 times, then taking a breath on the right side, then doing the windmill arm movement 3 times again and taking a breath on the left side, and so on. This exercise aims to improve swimmers' posture and technique in freestyle and to develop bilateral breathing coordination.

Figure 6. 3 Hand Pulling with Side Breathing (Right), 3 Hand Puling Side Breathing (Left)

Speed
Speed is an important factor in achieving success in swimming, especially in competitive events where time is a measure of performance. The key to increasing speed and developing good technique lies in effective training for swimming athletes. In the context of sports, speed refers to an athletes' ability to move quickly or complete a task or competition in the shortest possible time. Speed in swimming is the swimmer's ability to move quickly in the water. Understanding speed in swimming can focus on various aspects, including good swimming technique, propulsion, movement frequency, and endurance. Optimal speed in swimming is usually achieved through a good combination of these factors, and it is the main goal for swimmers to achieve it in competition [13].

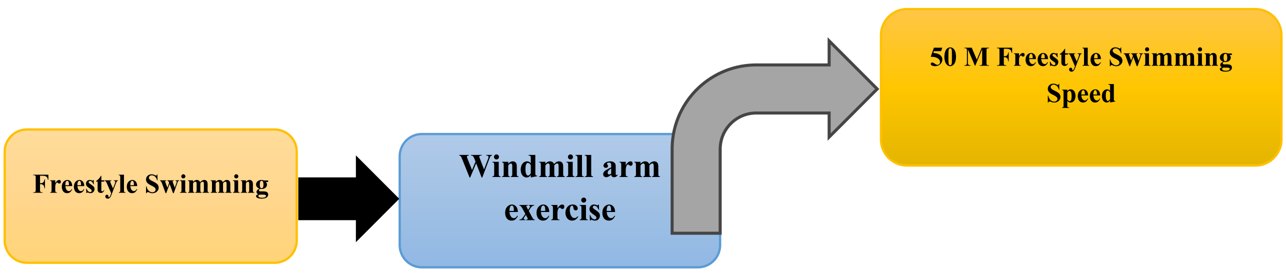

Figure 7. Conceptual Frameworks

Materials and Methods

This research uses quantitative research with experimental methods. This study used a one-group pre-test and post-test method. This design includes a pre-test before treatment and a post-test after treatment. This study aims to determine the effect of the windmill arm exercise on 50-meter freestyle swimming speed. The data collection methods used in this research were observation, documentation, and speed results of 50-meter freestyle swimming. The analysis technique used in this research is the "t test," with the condition that the sample must be homogeneous or normal.

Study participants
This research uses a total sampling technique. The sample in this study consisted of 45 junior athletes. This research was conducted in 12 meetings. In the first meeting, the sample carried out a pre-test, namely the 50 m freestyle swimming test, then the second meeting until the 11th meeting. After finishing the treatment, the group was given another test as a final test (post-test) 50 meters freestyle swimming to see if there was any improvement from the treatment (windmill arm) given.

Study organization
The research design used in this research is experimental research. Experimental research is carried out to see the causal relationship between variables. The intervention program exercises were carried out three times a week. Each exercise session in the experimental group lasted 45 minutes. This intervention program was implemented for 4 weeks with 12 meetings. The pre-test was carried out at the first meeting. The second meeting until the 11th meeting was given treatment, and the last meeting, namely meeting 12, held a final exam, namely the post-test.Statistical analysis

Instruments
In this study, the instrument was carried out by the sample swimming 50 meters freestyle in the pre-test and post-test. The tools used in carrying out this research are swimming pools, stopwatches, star flags, time-recording stationery, and others. The implementation procedure is that test participants (athletes) swim using freestyle over 50 meters. The time required for the sample to swim freestyle with 50 meters was recorded as research data, which will be analyzed to answer the research hypothesis.

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Validity and Reliability

Data Analysis

In a study two types of analysis can be used, namely statistical and non-statistical analysis Because this research data is in the form of numbers, this data was analysed using statistical analysis. To analyse the experimental results using pre-test and post-test, the formula is:

With Information:
X1 = Average value of pre-test results
X2 = Average value of post test results
S = Pooled standard deviation
S2 = Combined Variation (population Deviation)
n 1 = Number of pre-test students
n 2 = Number of post-test students
S12 = Data variance in post-test
S22 = Data variance in the pre-test

Data analysis aims to see whether the difference in the average score of the pre-test and post-test results is significant or not. To analyze the data, the author used a one-party t-test. Before carrying out the t-test, normality and homogeneity tests are carried out, which will then be processed with the help of the SPSS 12 program.

$$t = \frac{X1 - X2}{s\sqrt{\frac{1}{n^1} + \frac{1}{n^2}}}$$

$$S2 = \frac{(n_1 - 1)\,S_1^{\,2} + (n_2 - 1)S_2^{\,2}}{n_1 + n_2 - 2}$$

Normality test

This research aims to determine if the data follows a normal distribution using the Kolmogorov-Smirnov test, with data considered normal if significance is > α (0.05) or K-S count < K-S table.

Test of homogeneity of variance

The homogeneity test assesses whether the two groups have similar variance. The formula used is the F test which is said to be homogeneous if Fcount ≤ Ftable

Hypothesis testing

After carrying out the normality test and data homogeneity test, a hypothesis test is carried out to find out whether there are differences in the training results. In this case, an average similarity test is carried out, namely a one-party test with a statistical hypothesis.

What is proposed:
H0: X1 = X2 (There is no significant effect of windmill arm exercise on the 50-meter freestyle swimming speed of junior athletes).

Ha: X1 ≠ X2 (There is a significant effect of exercise using a windmill arm on swimming 50 meters freestyle in junior swimming athletes).

Result

From the picture above, it can be seen that the comparison between the pre-test and post-test results shows. The comparison of pre-test and post-test results shows a standard deviation of 1.95710 and a mean standard error of 0.29175 for the pre-test. In the post-test, a standard deviation of 2.83445 and a mean standard error of 0.42253 were obtained. Each test had a sample size (n) of 45.

Table 1. Pre-test data (50M Freestyle)

Sample	Pre-test	Sample	Pre-test	Sample	Pre-test
X1	52.30	X16	52.08	X31	51.04
X2	50.20	X17	53.04	X32	51.00
X3	50.02	X18	52.10	X33	53.07
X4	45.20	X19	51.22	X34	53.08
X5	54.70	X20	52.06	X35	52.05
X6	49.26	X21	53.07	X36	52.04
X7	51.22	X22	54.02	X37	53.08
X8	47.95	X23	51.20	X38	51.04
X9	46.75	X24	52.03	X39	52.06
X10	54.26	X25	52.08	X40	51.05
X11	53.01	X26	53.15	X41	52.05
X12	52.54	X27	53.10	X42	53.06
X13	53.60	X28	52.08	X43	50.20
X14	52.95	X29	51.01	X44	48.11
X15	53.20	X30	54.06	X45	49.40

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Table 2. Post-test data (50M Freestyle)

Sample	Pre-test	Sample	Pre-test	Sample	Pre-test
X1	45.20	X16	45.13	X31	44.22
X2	43.11	X17	46.22	X32	43.31
X3	42.00	X18	44.50	X33	48.29
X4	38.19	X19	47.28	X34	49.03
X5	50.19	X20	46.02	X35	46.25
X6	44.29	X21	48.03	X36	47.21
X7	46.52	X22	47.00	X37	48.59
X8	42.17	X23	47.23	X38	48.39
X9	41.06	X24	49.28	X39	49.07
X10	48.05	X25	48.05	X40	47.31
X11	46.02	X26	49.02	X41	49.27
X12	42.17	X27	47.07	X42	49.10
X13	44.19	X28	45.30	X43	45.09
X14	43.20	X29	47.57	X44	40.24
X15	47.07	X30	49.22	X45	41.24

Table 3. Pretest data frequency

Mark	Frequency
45,2-47,2	2
47,3-49,3	3
49,4-51,4	12
51,5-53,5	23
53,6-55,6	5
55,7-57,7	0
n	45

Information:
Greatest value = 54.7, Smallest value = 45.2, Range = 9.5, Many classes (Interval) = 6, Class Length (Interval) = 3

Table 4. Post-test data frequency

Mark	Frequency
38.19-43.19	8
43.20-48.20	26
48.21-53.21	11
53.22-58.22	0
59.23-64.23	0
64.24-69.24	0
n	45

Information:
Greatest value = 50.19, Smallest value = 38.19, Range = 12, Many classes (Interval) = 6, Class Length (Interval) = 6

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Table 5. Paired Sample Statistics

		N	Std. Daviation	Std. Error Mean
	Mean			
Pair 1	Pre-test 50m Freestyle Swimming	45	1.95710	.29175
	Post-test 50m Freestyle Swimming	45	2.83445	.42253

Table 6. Data from research test results

Data	n	Mean	Standard Deviation	Worst Score	Best Score	Range
Pre-test	45	51.6842	1.95710	54.70	45.20	9.5
Post-test	45	45.9324	2.83445	50.19	38.19	12

The table above shows the differences in results between the pre-test and post-test. In the pre-test (n = 45), the mean was 51.6842, with a standard deviation of 1.95710, a worst score of 54.70, a best score of 45.20, and a range of 9.5. In the post-test (n = 45), the mean was 45.9324, with a standard deviation of 2.83445, a worst score of 50.19, a best score of 38.19, and a range of 12.

Table 7. Normality Test

One – Sample Kolmogorov-Smirnov Test							
N	Normal Parameters^{a,b}		Most Extreme Differences			Test Statistic	Asymp. Sig. (2-tailed)
	Mean	Std. Deviation	Absolute	Positive	Negative		
45	0.0000000	1.88826113	0.93	0.060	−0.093	0.093	0.200^{c,d}

a. Test distribution is Normal, b. Calculated from data, c. Liliefors Significance Correction, d. This is a lower bound of the true significance

Based on the normality test results from the One-Sample Kolmogorov-Smirnov Test, the sample size was 45, with a mean residual of 0 and a standard deviation of 1.888. The largest difference between the sample and theoretical normal distribution is 0.093, with positive and negative values of 0.060 and -0.093, respectively. The statistical value of the Kolmogorov-Smirnov test was recorded at 0.093, and the resulting Asymp.Sig (p-value) significance value was 0.200. Since the p-value is greater than 0.05, the normality assumption is accepted. Thus, the residual data tested is normally distributed, so that the assumption of normality in this analysis is met.

Table 8. Homogeneity Test

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Results	Base on Mean	7.982	1	88	0.006
	Base on Median	7.193	1	88	0.009
	Base on Median and with adjusted df	7.103	1	84.524	0.009
	Base on trimmed mean	7.709	1	88	0.007

The table above shows the results of the homogeneity test based on the mean, with a Levene statistic of 7.982 (df = 1, 88) and a significance of 0.006, on base on mean with a result of 7.193, with df 1, df2 results of 88, with sig. of.009, based on median and with adjusted df with a result of 7,103, with df 1, df2 of 84,524, with sig..009, and on the base on time mean the result is 7.709, with df 1, with df 2, with sig..007. The homogeneity test results show a p-value greater than 0.05, indicating that the data is homogeneous.

Based on the results of the Test of Homogeneity of Variances using the Levene test, several statistical values were obtained as follows: test based on the average shows Levene's statistical value of 7.982 with a p-value of 0.205. Based on median and median with adjusted degrees of freedom, Levene's statistical value is 7.103 with a p-value of 0.095. The test based on the trimmed mean produces a statistical value of 7.709 with a p-value of 0.090.

1. Levene's test is used to determine if the variance between groups is homogeneous. The null hypothesis states that the variances between groups are equal.
2. In these results, all p-values are greater than 0.05, namely 0.205, 0.095, and 0.090. Since the p-value is greater than 0.05, we do not reject the null hypothesis, which means there is no significant difference in variance between groups.

Thus, it can be concluded that the variance between groups in this data is homogeneous, fulfilling the assumption of homogeneity of variance.

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Table 9. T test

Data	n	Mean	Standard Deviation	Sig. (2-tailed)
Pretest 50m freestyle swimming - Posttest 50m freestyle swimming	45	5.75178	1.89476	0.000

The paired t test (paired-samples t-test) is a statistical method used to compare the means of two related data sets, such as the results of measurements taken before and after intervention on the same subject. In this context, the t test was used to compare the 50-meter freestyle swimming times before and after training or intervention in the same group (45 athletes).
The following is an explanation of the t test:
1. Null Hypothesis (H0): There is no significant difference between the pre-test and post-test averages. This means that the training or intervention provided does not have a significant influence on the athlete's swimming time.
H0: µ pretest = µ post-test
2. Alternative Hypothesis (H1): There is an average difference between the pretest and post-test results. This means that training or intervention has a significant effect on athletes' swimming times.
H1: µ pretest ≠ µ post-test
3. T statistic: This test compares the average difference in pretest and post-test results to the standard deviation. If the t value obtained is large enough, then we reject the null hypothesis.
4. The 2-tailed significance (p-value) from the t-test is 0.000. In this case, a p-value of.000 (smaller than 0.05) indicates that there is a very significant difference between the pretest and post-test results. This means that the test results show very strong evidence to reject the null hypothesis, which means that the training or intervention carried out on athletes has a significant effect on improving their performance.
The t-test results indicate a statistically significant improvement in athletes' 50-meter freestyle performance, with an average increase of 5.75 seconds.

Table 10. T test

		Paired Sample Test, Paired Differences 95% Confidence Interval of the Difference							
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailet)
Pair 1	Pretest Swim 50 m Freestyle - Postest Swim 50 m Freestyle	5.75178	1.89476	0.28245	5.18253	6.32103	20.364	44	.000

The table above shows the results of the homogeneity of variances test with a base on mean result of 7,982, with df 1, df 2 a result of 88, with sig..006, on base on mean with a result of 7.193, with df 1, df 2 results of 88, with sig..009, based on median and with adjusted df with a result of 7,103, with df 1, df 2 of 84,524, with sig..009, and on the base on time mean the result is 7.709, with df 1, with df 2, with sig..007. The results of the homogeneity test obtained a significant value from the group p > 0.05, which means the data is homogeneous.

Table 11. Athletes' abilities before being given treatment

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
45.2-47.2	2	4.4	4.4	2: 45 x 100 = 4.4
47.3-49.3	3	6.7	6.7	3: 45 x 100 = 6.7
49.4-51.4	12	26.7	26.7	12: 45 x 100 = 26.7
51.5-53.5	23	51.1	51.1	23: 45 x 100 = 51.1
53.6-55.6	5	11.1	11.1	5: 45 x 100 = 11.1
55.7-57.7	0	0	0	0: 45 x 100 = 0
Total	45	100	100	45: 45 x 100 = 100

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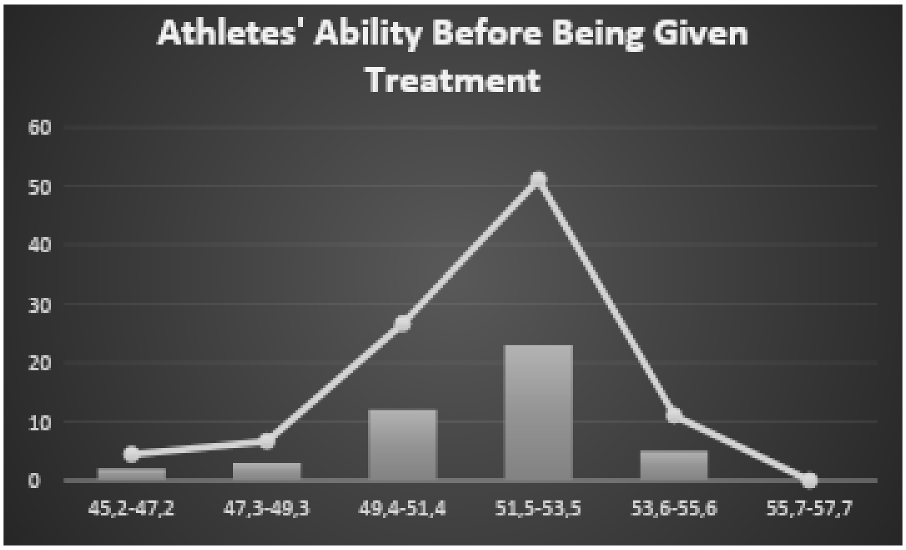

Figure 8. Athletes' abilities before being given treatment

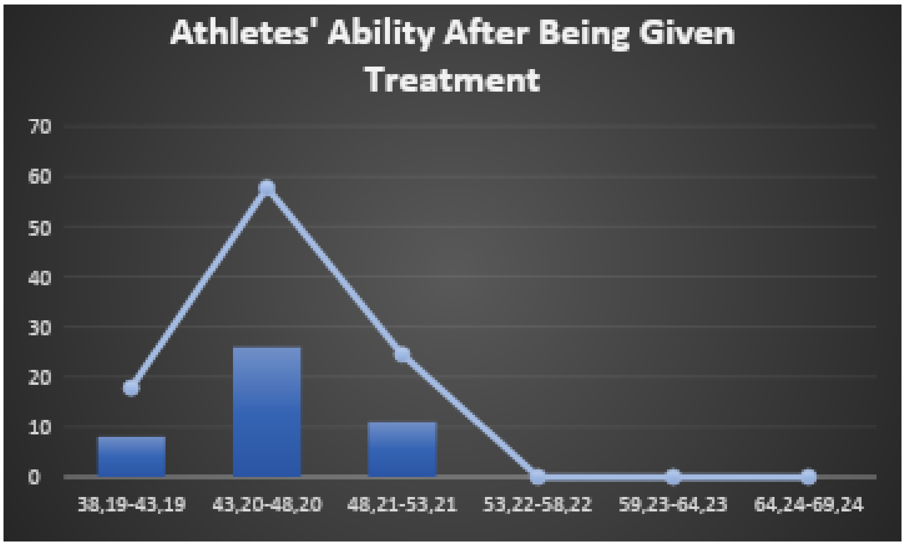

Figure 9. Table. Athletes' abilities after being given treatment

Table 12. Table. Athletes' abilities after being given treatment

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
38.19-43.19	8	17.8	17.8	8: 45 x 100 = 17.8
43.20-48.20	26	57.8	57.8	26: 45 x 100 = 57.8
48.21-53.21	11	24.4	24.4	11: 45 x 100 = 24.4
53.22-58.22	0	0	0	0: 45 x 100 = 0
59.23-64.23	0	0	0	0: 45 x 100 = 0
64.24-69.24	0	0	0	0: 45 x 100 = 0
Total	45	100	100	45: 45 x 100 = 100

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Discussion

Arm movement in freestyle swimming primarily serves as a propulsive force and helps control body balance. Research on windmill arm exercises in 50-meter freestyle swimming shows a significant improvement in speed among trained athletes [14]. This is evident from the results of the initial and final tests on junior athletes. However, the arm muscles are a primary support force in swimming. Freestyle is considered the fastest swimming style due to its unrestricted stroke technique. Speed is a critical element in swimming and many other sports. In swimming, speed is one of the absolute things that supports and measures achievement. Achievement of speed in movement is a quality that allows people to move or carry out similar or dissimilar movements [15]. According to [16], achieving maximum speed is essential for success in swimming. In swimming, hand movement is one of the main keys to gaining maximum speed. Therefore, the appropriate training or programs are crucial for junior athletes. According to [17], swim rotation exercises, such as the windmill arm, can increase 50-meter freestyle swimming speed. Apart from that, according to [18], by training the arms, the speed of the body parts in swimming, the arms produce greater power in each pull and make the swimmer swim faster. A good shoulder range of motion enables swimmers to reach further with each stroke, increasing force and allowing faster swimming.

Specific training to increase speed and develop good technique is the key in the preparation of great swimming athletes. In the context of sports, speed refers to an athlete's ability to move quickly or complete a task or competition in the shortest possible time. In swimming, speed is defined as the swimmer's ability to cover distance quickly in the water. Understanding speed in swimming can focus on various aspects, including good swimming technique, propulsion, movement frequency, and endurance. Optimal swimming speed is usually achieved through a combination of these factors and is the primary goal in competitive swimming [18]. Data analysis and hypothesis testing confirm a significant effect of windmill arm exercises on 50-meter freestyle speed in junior athletes. Coaches are encouraged to use windmill arm exercises to improve 50-meter freestyle speed. Training should be gradual and carefully structured. For future research, it is recommended to conduct similar studies on a larger scale, incorporating diverse programs over a longer duration. We can probably see several other factors that have not been considered.

Windmill arm exercises offer long-term benefits for shoulder and back health, which may interest physiotherapists. Research suggests potential benefits, including improved shoulder mobility. Because the windmill arm involves a full rotation of the shoulder [19]. According to [20]. In the long term, this movement can increase the flexibility of the shoulder joint, which is beneficial for those who have limited range of motion due to injury, poor posture, or medical conditions such as frozen shoulder. This dynamic rotational movement helps maintain optimal mobility by lubricating the joints and preventing stiffness. Windmill arm exercises can improve motor coordination. The repetitive, coordinated movements in windmill exercises train fine motor control as well as proprioception (awareness of body position) [21]. In the context of physiotherapy, these benefits are relevant to helping patients recover movement and coordination after injury or surgery. In addition, it can be a long-term injury prevention; with regular exercise, the shoulders and upper back become more flexible and stable. This is especially important for people who frequently use their arms in work or sports activities. With more stable joints and stronger muscles, the risk of injuries such as tendonitis, muscle strains, or rotator cuff injuries can be significantly reduced [22]). In the context of physiotherapy, [23] also added, these exercises can be utilized as part of a rehabilitation or maintenance program, particularly for patients with a history of shoulder injury, poor posture, or mobility problems. The windmill arm exercise can be adapted to various ability levels, making it suitable for diverse rehabilitation needs. Overall, the windmill exercise can be a useful tool in maintaining shoulder and back joint health, improving mobility, and reducing the risk of long-term injury when performed regularly and with correct technique. Thus, it can be concluded that the windmill arm exercise is a multifunctional tool that can be used in physiotherapy for the rehabilitation of shoulder injuries in athletes as well as injury prevention in individuals with repetitive activities. These exercises offer mobilization, strengthening, and stability benefits, which can be combined with an evidence-based physiotherapy program. Physiotherapists can adjust the intensity and variety of movements to suit the patient's needs, making these exercises relevant for both the initial phase of recovery and long-term maintenance programs [24].

The windmill arm exercise also involves circular movements that combine various biomechanical components that affect the musculoskeletal system, especially the shoulders, arms, and upper back. For physiotherapists, understanding the biomechanics of these movements can help design more effective rehabilitation programs and prevent injury by maximizing the optimal use of muscle and joint structures [25]. During the windmill movement, the elbow joint moves in a mostly straight position (extension), but there are times when slight flexion may occur, depending on the variation of the movement. Although the elbow joint is not significantly involved in circular movements of the shoulder, the muscles associated with the elbow, such as the biceps brachii and triceps brachii, still play a role in stabilizing the arm. These exercises provide coordinated stimulation to the muscles that work together to maintain joint health and function, making them an important tool in rehabilitation and injury prevention [26].

The advantage of windmill arms in swimming speed can increase shoulder flexibility; more flexible shoulders allow for a greater range of motion in the pull and recovery phases of swimming. This allows for a more powerful and extended stroke, enhancing propulsion and movement efficiency. Furthermore, this exercise increases awareness of shoulder position, which is important for optimizing arm position while in the water. A more precise position allows for more effective force when pushing through the water, which increases speed). The windmill arm exercise benefits shoulder stability by strengthening the rotator cuff muscles [27]. According to Taylor [28], windmill arms target small muscles that are rarely activated at high intensity in other exercises. Muscles such as the infraspinatus and teres minor stabilize the shoulder joint, reducing injury risk for swimmers performing repetitive movements. Scapular Stability: This exercise involves muscles such as the serratus anterior and trapezius to stabilize the scapula during arm movements in the water. [29] also added. This stability is important to reduce the risk of

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shoulder injuries that often occur in swimmers, such as impingement or tendonitis. Strength training directly focuses on increasing muscle mass, power, and functional strength. Exercises such as push-ups, pull-ups, lat pulldowns, and rotator cuff exercises use external weights to build the strength needed during swimming. Increasing propulsive strength, exercises such as pull-ups and push-ups target the back and chest muscles used in the pull and push phases of swimming. Strengthening these muscles directly increases the swimmer's propulsion and speed in the water. Explosive Power: Explosive weight training, such as medicine ball throws or plyometric push-ups, helps improve arm explosive power, which is essential for achieving maximum propulsion during each stroke. Strength training that targets large muscles, such as the deltoids, pectoralis major, and triceps, provides additional stability to the shoulder, increasing support for the joint during repetitive movements. Exercises that use resistance bands or light dumbbells to specifically target the rotator cuff can improve dynamic stability of the shoulder, reducing the risk of injury in swimmers. Breathing technique in swimming is essential for both oxygenation and movement efficiency. Integrating proper breathing technique can improve swimming speed and shoulder stability.

Table 13. Comparison of Effectiveness

Criteria	Windmill Arm	Strength Training	Breathing Techniques
Swimming Speed	Improves shoulder flexibility and positional control	Increase the thrust in water	Improve efficient body rhythm and position
Shoulder Strengthening	Strengthens shoulder stabilizer and rotator muscles	Strengthens the large muscles of the shoulders and arms	Not significant in strengthening
Shoulder Stability	Improving dynamic shoulder stability through proprioceptive control	Providing structural stability through global strengthening	Prevent tension and injury through muscle relaxation
Risk of Injury	Reduces the risk of impingement and tendonitis	Reduces the risk of impingement and tendonitis	Reduces the risk of tension due to poor breathing
Shoulder Flexibility	Increase shoulder range of motion	Not focused directly on flexibility	Increase postural flexibility
Proprioception Awareness	Improves neuromuscular control	Not really targeting proprioception	Helps general body coordination

From the statements above, it can be concluded that each method—windmill arm, strength training, or breathing techniques—has unique advantages in enhancing swimming performance and shoulder stability. The windmill arm exercise is effective in enhancing shoulder mobility, dynamic stability, and proprioceptive awareness, making it ideal for rehabilitation and shoulder injury prevention in swimmers [30]. Strength training targets large muscle groups essential for increasing swimming speed and preventing injuries from structural weaknesses, but it is less effective for mobility and fine motor control [31]. Breathing techniques are essential for movement efficiency, reducing muscle tension, and maintaining shoulder stability through good posture, though they are not significant for muscle strengthening [32]. Combining these three methods may be the most effective approach to enhance swimming performance and prevent injury [33].

Effectively incorporating windmill arms, strength training, and breathing techniques into a training program requires adjustments in intensity, duration, and frequency. Here are some practical tips for sports physiotherapists to design safe and effective programs for shoulder injury rehabilitation and improving sports performance, such as swimming [34].

Table 14. Incorporating exercises

Name of exercise	Main functions	Intensity/Duration	Frequency	Progression
Windmill Arm	Shoulder stability, proprioception, flexibility	Intensity: Low to moderate. Focus on slow, controlled movements to avoid excessive stress on the shoulder joints. Duration: 3-4 sets, 10-15 reps per arm.	3-5 times per week. Can be incorporated into a daily routine, especially as part of a warm-up or cool-down.	After 2-3 weeks, increase the speed and size of the arm circle to enhance motor control and stabilizer strength. Once adapted, the windmill arm exercise can be performed with light weights (e.g., 1-2 kg dumbbells) to increase shoulder muscle workload.
Strength Training for Shoulders and Arms	Strength training for shoulders and arms focuses on large muscles like the deltoids, pectoralis, and latissimus dorsi, which helps prevent shoulder injuries, improve propulsion in swimming, and enhance posture.	Intensity: Moderate to high. Use a weight that can be lifted for 8-12 reps with a feeling of fatigue at the end of the set. Duration: 3-4 sets of 8-12 reps for each exercise. Exercises include pushes, pullups, overhead presses, or pulldown exercises.	Frequency: 2-3 times per week, focusing on full-body exercises involving the shoulders.	After 2-3 weeks, increase the weight or add more reps to encourage strength adaptations. Ensure that shoulder and back muscles have sufficient recovery time (48 hours between sessions). Perform rotator cuff exercises with resistance bands on lower intensity days to specifically target shoulder stabilizer muscles.

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Name of exercise	Main functions	Intensity/Duration	Frequency	Progression
Breathing Techniques	Breathing control enhances movement efficiency, body stabilization, and reduces shoulder and neck tension, which is crucial for maintaining proper posture and preventing muscle strain.	Intensity: Low to moderate. Focus on controlled breathing throughout the exercise, Duration: 3-5 sets, 1-2 minutes per set, with a focus on regular, relaxed breathing. especially during the rest or recovery phase	Frequency: Can be done daily, especially before heavy training sessions or during post-workout recovery.	Teach athletes diaphragmatic breathing techniques to improve lung capacity and oxygen efficiency during swimming. This technique can also help reduce shoulder tension. Incorporate it into recovery routines to relax shoulder and neck muscles, especially for athletes who feel muscle tension during swimming. Practicing rhythmic breathing can further alleviate shoulder tension.

In conclusion, incorporating windmill arms, strength training, and breathing techniques into a rehabilitation program requires balancing frequency, intensity, and duration. Sports physiotherapists can adjust the intensity of these exercises based on the athlete's specific needs, rehabilitation phase, or performance improvement goals. The key to success is gradual progression, allowing adaptation without injury risk, and ensuring these exercises are well integrated into the athlete's routine [35].
Openly addressing methodological limitations is essential for transparency and credibility in physiotherapy research and recommendations [36]. In evaluating exercises like windmill arms for shoulder rehabilitation and performance, several factors must be considered to ensure observed benefits result from the exercise itself and a well-structured, measurable approach [37]. In this context, a control group could be individuals who do not participate in the windmill exercise program but who do another intervention (e.g., manual therapy or conventional strength training). Without a control group, it is challenging to conclude that improvements in shoulder stability or swimming speed are due solely to windmill training, rather than other factors like rest, activity modification, or supervision [38]. For future research, it is advisable to include a control group in the study or evaluation program. This group could perform standard interventions or other methods to compare the effectiveness of sleep windmill exercises, stress levels, medication use, and individual health histories. Without controlling and monitoring these factors, training results may not be a direct reflection of the training program but rather of lifestyle changes or other external factors.
This exercise offers long-term benefits for shoulder and back health, especially if practiced regularly and with proper technique [39]. Some speculations of its benefits that are relevant to physiotherapists, 1) As better shoulder mobility and stability. The windmill exercise rotates the shoulder at various angles, improving shoulder joint mobility. The shoulder joint is a very mobile joint but is susceptible to injury, mainly due to lack of stability due to limited movement or incorrect movement patterns. The windmill movement helps maintain full range of motion around the shoulder joint and strengthens the muscles that support shoulder stability, such as the rotator cuff muscles. Long-term benefits can maintain or even improve shoulder mobility and prevent problems such as stiff shoulder or impingement syndrome. 2) Shoulder Injury Prevention: This exercise engages stabilizing muscles like the trapezius, deltoid, and rotator cuff. By simultaneously strengthening and stretching these muscles, this exercise can help reduce the risk of shoulder injury. This can be especially useful for those involved in activities that involve repetitive overhead movements, such as athletes or manual workers. Long-term benefits can reduce the likelihood of rotator cuff injuries and improve the body's ability to adapt to the mechanical stress placed on the shoulder. 3) Improve back flexibility and posture. This exercise requires arm and upper body coordination, improving flexibility and posture. This circular movement involves gentle rotation of the thoracic spine and helps release tension in this area. Long-term benefits: This exercise can contribute to the prevention of upper back pain or back muscle tension due to poor posture, especially for those who frequently sit or slouch. 4) Improve circulation and joint fluid flow, repetitive windmill movements improve circulation around the shoulders and stimulate synovial fluid flow in the joints. It helps maintain joint lubrication and promotes cartilage health, which is important for the prevention of osteoarthritis and other joint problems. In the long term, these exercises can help maintain joint health and prevent joint stiffness or degeneration due to age or inactivity. 5) Windmill exercises serve as active stretches, enhancing flexibility and neuromuscular control. This means that the muscles work to stabilize the joints as the body moves through its full range of motion. In the long term, this can help reduce muscle tension around the shoulder and back joints, as well as improve muscle coordination [40] (Powell., 2022).
Long-term benefits include increased shoulder flexibility and reduced risk of strains and overuse injuries. 6) Rehabilitation and recovery for patients who are in the recovery phase from a shoulder or back injury, Windmill exercises can gradually restore joint strength and mobility without excessive stress on injured structures. Long-term benefits: these exercises can be used as part of long-term therapy to help patients recover fully and prevent recurrence of injuries. So, it can be concluded that windmill arm exercises that are done regularly have the potential to provide many long-term benefits for the health of the shoulder and back joints, including increased mobility, injury prevention, improved posture, and increased blood circulation around the joints [41]. For physiotherapists, these exercises can be a useful tool in rehabilitation, injury prevention, and improving patients' quality of life.

Conclusion

In carrying out this research, the test was carried out twice, namely the initial test and the final test. The initial test was carried out with the aim of seeing the initial capabilities of the sample before the experiment and the final test was carried out with the aim of seeing to what extent because of the experiment there was a significant improvement. This is done by comparing the final and initial test results to the t-table value at a significance level of (df) = n - 1 = 10. If tcount is greater than ttable, the increase in final test results was due to providing maximum training in ac-

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cordance with the established training program. According to [42], "a new exercise will show effects after six weeks, with a 30% improvement if performed three times a week."

The pre-test results from 45 junior swimming athletes showed a highest score of 54.70, a lowest score of 45.20, a mean of 51.6842, a standard deviation of 1.95710, and a range of 9.5. After the pre-test, participants underwent 10 training sessions, followed by a post-test to assess changes in freestyle swimming ability. Statistical calculations show a significant effect of windmill arm training on 50-meter freestyle swimming speed in junior athletes. The calculated t-value (20.364) is compared to the critical t-value (2.000) with (df) = n - 1 = 9 at a significance level of $\alpha = 0.05$. Thus, t_calculated (20.364) > t_table (2.000). Additionally, the table shows a significance level of $\alpha = 0.05$. This indicates a significant improvement in the 50-meter freestyle swimming speed of the sample group.

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