IMPROVING BACKSTROKE SWIMMING TECHNIQUE BY USING UNCONVENTIONAL OBJECTS

УДОСКОНАЛЕННЯ ТЕХНІКИ ПЛАВАННЯ НА СПИНІ З ВИКОРИСТАННЯМ НЕТРАДИЦІЙНИХ ОБ'ЄКТІВ

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Abstracts

Swimming is one of the most important and useful skills, alongside running and walking, that is worth learning at least in its basic form. It is a very enjoyable sport that has a positive impact on our entire body. Swimming is suitable for people of all ages, from the youngest to seniors. It is considered to be one of the healthiest forms of physical activity and has a significant influence on our respiratory, circulatory, and immune systems. Moreover, it is increasingly viewed as a form of relaxation, leading people of all ages to engage in swimming more often. Learning to swim both benefits our health and also enables us to participate in various water sports such as windsurfing, sailing, and kayaking, where we have continuous contact with water. Therefore, many parents enroll their children in swimming lessons from a young age to familiarize them with this element – water. During swimming lessons, children are taught to follow safety rules regarding staying near water and moving in it, so as not to pose a threat to themselves or others.

The focus of the research is to study the effects of using unconventional equipment in backstroke swimming technique training. The main objective is to determine whether regular swimming training with unconventional equipment affects changes in the backstroke swimming technique of 10 to 11-year-old children. Two groups were studied: group 1, swimming with cotton gloves, and group 2, swimming without unconventional equipment. The technical training sessions for the backstroke style lasted three weeks, and the progress was evaluated through a 4x25 m timed test before and after the training. The research was conducted with 10 students (5 girls and 5 boys) from the fourth grade of a primary school in Torun, Poland. The results showed that most participants improved their backstroke swimming performance in the second 4x25 m timed test. Some changes in times, speed, stroke length, stroke rate, and technique index were significant. However, it is impossible to attribute these improvements solely to the use of unconventional equipment during training because both groups, Group 1 using cotton gloves and Group 2 without unconventional equipment, improved their results, which were not statistically significant in both groups. In conclusion, after analyzing the research topic and answering the research questions, one main conclusion can be drawn: age, commitment, appropriate exercise selection, and varied training sessions have a significant impact on improving a swimmer's technical abilities.

Key words: swimming, equipment, training, speed.

Плавання є однією із найважливіших і корисних навичок поряд з бігом і ходьбою, якої варто навчитися хоча б у базовій формі. Це дуже приємний вид спорту, який позитивно впливає на весь наш організм. Плавання підходить для людей будь-якого віку – від найменших до людей похилого віку. Вважається, що це одна із найздоровіших форм фізичної активності, яка має значний вплив на нашу дихальну, кровоносну та імунну системи. Крім того, воно все частіше розглядається як форма релаксації, що змушує людей різного віку частіше займатися плаванням. Навчання плавання приносить користь нашому здоров'ю, а також дає нам змогу займатися різними водними видами спорту,

такими як віндсерфінг, вітрильний спорт і каякінг, де ми постійно контактуємо з водою. Тому багато батьків записують своїх дітей на заняття з плавання змалечку, щоб познайомити їх із цією стихією – водою. На заняттях з плавання дітей вчать дотримуватися правил безпеки щодо перебування біля води та пересування в ній, щоб не створювати загрози собі та оточуючим.

Метою дослідження є вивчення ефектів використання нетрадиційного обладнання для навчання техніки плавання на спині. Основна мета – визначити, чи впливають регулярні заняття плаванням з нетрадиційним обладнанням на зміну техніки плавання на спині дітей 10–11 років. Досліджувалися дві групи: 1 група – плавання в бавовняних рукавичках, 2 група – плавання без нетрадиційного спорядження. Технічні тренування зі стилю плавання на спині тривали три тижні, а прогрес оцінювався за допомогою тесту на час 4х25 м до та після тренування. Дослідження проводилося за участю 10 учнів (5 дівчат і 5 хлопчиків) четвертого класу початкової школи м. Торунь, Польща. Результати показали, що більшість учасників покращили свої результати плавання на спині в другому тесті на час 4х25 метрів. Деякі зміни в часі, швидкості, довжині гребка, частоті гребка та індексі техніки були значними. Однак неможливо пояснити ці покращення лише використанням нетрадиційного обладнання під час навчання, оскільки обидві групи – група 1 з використанням бавовняних рукавичок і група 2 без нетрадиційного обладнання – покращили свої результати, які не були статистично значущими в обох групах. У підсумку, проаналізувавши результати дослідження, можна зробити один головний висновок: вік, прагнення, відповідний вибір вправ та різноманітні тренувальні заняття мають значний вплив на вдосконалення технічних можливостей плавця.

Ключові слова: плавання, техніка, тренування, швидкість.

Introduction. Due to its anatomical structure and composition, the human body will assume vertical position when submerged in water [8; 11]. Legs with a large muscular mass and heavy bones sink lower than the torso, which contains air and a greater amount of adipose tissue. The uneven distribution of mass causes gravity and buoyancy centers to be at different positions [2].

The point of the gravity force application is in the vector of the body's center of mass (taking into account tissue density, limb length, their current position in relation to each other and the torso, and the amount of air in the lungs). The point of the buoyant force application lies at the geometric center of the human body. In practice, these forces never coincide. It is assumed that the buoyancy center is located near the stomach, while the gravity center is approximately 10–15 cm below. As a result of this phenomenon, a torque arises.

Human movement in water depends on a number of factors that have been studied for years. The methods used in hydrodynamics, specifically in modeling, are intended to study and upgrade the results. In recent years, a method of visualizing swimming techniques has been employed, involving the use of coloring substances in water that allow to observe the flow of water during the specific movement. The factors influencing the body in motion [11; 13] are:

Frontal resistance is the force influencing the front part of the swimmer's body, opposing the direction of body movement. The magnitude of resistance depends on the cross-sectional area and shape of the swimmer's body, as well as the speed of movement in water, and the temperature and density of water. The density of water equals approximately 0.9997 g/cm^3, which is 770 times more than air density (approximately 0.00129 g/cm^3). Water resistance decreases by nearly 7 percent with the increase of water temperature from 18°C to 24°C. This decrease is likely due to the swimmer's body becoming more flexible and streamlined as the water temperature rises. Frictional resistance, also known as aerodynamic resistance, is the sum of forces influencing the small parts of the body. This depends on water viscosity, the swimmer's body smoothness, density, or swimsuit. The smoothness of the swimmer's body is affected by frictional force generated due to the interaction of water molecules and the moving swimmer [1; 9].

For many years, swimsuits have been designed to get the lowest friction coefficient possible. FINA (International Swimming Federation) prohibits the use of chemical substances to reduce frictional resistance on the body. Lane allocation in final races at competitions is given to the best-performing participants based on the times they demonstrate in the qualifying rounds. These lanes are known as 'faster" lanes

as they are located farther from the pool's side walls, resulting in reduced frictional resistance. Vortex resistance, also known as 'tail drag": It is a phenomenon where water jets split and create vortices around the swimmer's legs [2; 10].

Progressive movement in water is the result of energetic movements of the swimmer's limbs, the interaction of muscular and hydrodynamic forces. It is connected with the production of driving force. This term means the sum of all forces which cause body movement [5; 12; 14]. As the swimmer moves, gravity and buoyancy change. When we emerge, for example, with our head or hands, the center of buoyancy is directed towards the legs, and buoyancy decreases. Buoyancy decreases when a large body mass floats to the surface, and then the body sinks faster. The swimmer's movement in the water is accompanied by the formation of water resistance (R) and supporting forces (SF), which grow with the swimming speed increase [6].

The pressure of the hand on the water leads to the creation of a pressure difference between the back and palmar surfaces. It inclines the body in motion. The swimmer moves in the opposite direction to the movement of the rowing limb. To increase the speed of swimming, it is necessary to optimize the strength of rowing movements, the pace, scope and accuracy of the movements performed, as well as the position of the body in the water so that it provides the least frontal resistance. The reduction in frictional resistance can be minimized due to the use of caps, full body shaving and professional clothing. In swimming movements, we distinguish three translational movements of a swimmer. Waterproof components directed backwards dominate in the first case. In the second, the actions of the lifting force passing along the chord, predominate. In the third case, there are curvilinear eddies, similar to those that appear when a ship's propeller rotates. In speed swimming, rapid changes in the direction of the hand can be observed with the spread of circular vortices at the end of each push impulse. In the middle of the movement, when the hand changes direction, a large circular vortex spreads. Eddies of the current are first separated from the arm, which indicates that the float drive is already in the unsteady flow regime [3; 4; 11].

In free swimming, due to the acceleration of the smooth movement of the hand, the system of vortices stays organized longer. And only at the end of the phase the system of these moves is destroying. Rapid or excessive hand movements can cause random vortices to propagate, resulting in the loss of additional kinetic energy. The circulation of vortices is created by changing the direction of the hand movement, the rotation of the forearm and the angle of the arm flexion in the elbow joint. Movement in a plane transverse to the direction of movement of the float creates circulation of the flow, which determines a significant driving force of the float. This example demonstrates that the float can simultaneously create pushing forces [7; 8; 15].

The research pertains to the changes that occur when using unconventional equipment in backstroke swimming technique. The **aim of the research** is to examine whether regular swimming training with unconventional equipment has an impact on changes in the backstroke swimming technique of children aged 10–11 years. The research problem concerns changes that occur during regular swimming training with the use of unconventional equipment, with a focus on the technical aspect.

Methods of development, research tools.

In the study, a 4x25 m test was conducted in a 25-meter swimming pool. The participants got the task to complete the 25 m distance four times, gradually increasing swimming pace. The time difference between the first series and the fastest segment at maximum speed should be approximately 4–6 seconds. Subsequent series had to be completed 1.0–1.5 seconds faster than the previous ones. Each repetition was performed in a 1-minute cycle as the participants were children, and their rest time was extended. The measurement took place in the 15 m swimming zone, between the turning flags. Conducting the 4x25 m test allows us to assess individual changes in a swimmer's performance by swimming shorter distances. This study enables us to determine a swimmer's technical capabilities, such as swimming speed (ss), stroke rate (SR),

and stroke length (SL). The measurements were carried out using an indirect method. This method involves recording measurements with a video camera and then conducting actual measurements after the study by replaying the content on a computer. Additionally, a Wilcoxon test was conducted to compare the collected data from the two tests before and after the study to see if there were statistically significant changes.

During the 3-week training sessions, the research participants were divided into 2 experimental groups:

1. Group 1: During the training, they swam with cotton gloves: Michał K., Kristina A., Mariusz G., Jagoda N., and Maja T.

2. Group 2: During the training, they swam without any unusual equipment: Natalia K., Fabian S., Tymek M., Magda K., and Igor B.

Both experimental groups performed the same exercises and underwent the same training.

Organization of the research.

The study was conducted during a 3-week microcycle using indirect measurement methods, and included a group of 10 people. The training sessions took place at the school swimming pool. The author, who was also the class trainer, provided assistance during the measurements.

Start of the research: January 15, 2021 – execution of the first 4x25 m test (Test 1).

Completion of the research: February 8, 2021 – execution of the second 4x25 m test (Test 2).

A 3-week training cycle with the use of non-traditional equipment was incorporated into each training unit for the whole class. Technical exercises typically lasted around 60 minutes. Each exercise was performed for a minimum of 50 meters.

Characteristics of the studied group.

10 students (5 girls and 5 boys) from the 4th grade of the primary school at the School Complex in Torun participated in the study. The experiment included the 4th grade with a swimming profile, which totally consists of 16 students, including 7 girls and 9 boys, aged 10–11 years. Swimming classes in the specialized class last for 2 hours per day, 5 days a week. The classes take place at the school's full-size, six-lane swimming pool. Before the study commenced, each student underwent basic measurements, such as height and body weight (Table 1).

Table 1

Basic measurements of the studied participants

The participants under investigation	Body weight [kg]	Height [cm]	BMI
Krystina A.	36.5	140.0	18.4
Igor B.	33.5	141.0	16.6
Maja T.	35.5	131.0	20.4
Mariusz G.	35.0	142.0	17.4
Michał K.	40.0	150.0	17.8
Natalia K.	39.0	149.0	17.6
Tymoteusz M.	37.5	147.5	17.1
Jagoda N.	32.0	144.0	15.4
Magda K.	40.5	151.0	17.5
Fabian S.	33.5	141.0	16.5
$\bar{x}$	38.8	144.0	17.47
SD *standard deviation	6.82	6.65	1.32

Research results.

Assessment of swimmer's technical capabilities.

Swimming the 4x25 m test allows us to assess individual changes in this swimmer through the execution of shorter distances. Thanks to less fatigue resulting from longer rest periods between each series, it enables us to determine the swimmer's technical capabilities, such as swimming speed (ss), stroke rate (SR), and stroke length (SL).

Results of the first 4x25 m test in backstroke (Table 2).

In the test commencing the study, the time shown by Group 1 were highly diverse. The average time over a distance of 15 meters in the first series was 17.87 seconds. The best time in the first series was achieved by Michał, who completed it in 12.8 seconds. In the second series, the group's average time was 16.12 seconds, and the best time at this stage was recorded by Kristina – 13.4 seconds. In the third series, the average time for Group 1 participants was 15.83 seconds, and again with Kristina achieving the best time. In the fourth series, the average speed was 15.08 seconds, and the best

time was achieved by Mariusz – 12.9 seconds. Among the entire group, Mariusz completed the first test at the best increasing pace, with the following times: series 1: 17.70 seconds, series 2: 15.75 seconds, series 3: 14.65 seconds, series 4: 12.90 seconds. The average speed achieved by Mariusz was 15.25 seconds.

In test 1, the speed values for Group 2 varied (Table 3).

The average speed over a distance of 15 meters in the first series was 23.15 seconds. Natalia achieved the best time in the first series, completing it in 13.87 seconds. In the second series, the group's average speed was 18.57 seconds, and Natalia also recorded the best time at this stage with 14.64 seconds. In the third series, the average time for Group 2 participants was 16.66 seconds, and Natalia once again achieved the best time. In the fourth series, the average speed was 14.77 seconds, and Natalia demonstrated the best time of 13.58 seconds. Against the whole group, Igor swam at the best increasing pace with the following time results: series 1: 17.00 seconds, series 2: 16.1 seconds, series 3: 15.50 seconds, series 4: 15.00 seconds. The average speed achieved by Igor was 15.09 seconds.

The swimming speed of Group 1 participants in the 4x25 meters test generally increased with each subsequent series (Table 4).

Table 2

Time [s] obtained in the first study by swimmers from group 1 at various intensities, 4x25 m test GROUP 1

PARTICIPANTS	Intencity 1 [s]	Intencity 2 [s]	Intencity 3 [s]	Intencity 4 [s]
Michał K.	12.80	13.50	14.10	13.20
Kristina A.	14.78	13.40	13.55	14.21
Mariusz G.	17.70	15.75	14.65	12.90
Jagoda N.	20.98	18.04	16.76	15.59
Maja T.	23.10	19.90	20.09	19.50
$\bar{x}$	17.87	16.12	15.83	15.08
SD	4.25	2.84	2.67	2.68

Table 3

Times obtained in Study 1 by swimmers from Group 2 at various intensities, 4x25 m test GROUP 2

PARTICIPANTS	Intencity 1 [s]	Intencity 2 [s]	Intencity 3 [s]	Intencity 4 [s]
Natalia K.	13.87	14.64	14.08	13.58
Fabian S.	32.78	21.81	19.45	15.41
Tymek M.	30.40	20.95	18.48	14.88
Magda K.	21.70	19,40	15.80	15.00
Igor B.	17.00	16.10	15.50	15.00
$\bar{x}$	23.15	18.58	16.66	14.77
SD	8.24	3.10	2.23	0.70

Table 4

Swimming speed [vp] achieved by swimmers from Group 1 at various intensities in the 4x25 m test

PARTICIPANTS	Intencity 1 [m/s]	Intencity 2 [m/s]	Intencity 3 [m/s]	Intencity 4 [m/s]
Michał K.	1.17	1.11	1.06	1.14
Kristina A.	1.01	1.12	1.11	1.06
Mariusz G.	0.85	0.95	1.02	1.16
Jagoda N.	0.71	0.83	0.90	0.96
Maja T.	0.65	0.75	0.75	0.77
$\bar{x}$	0.88	0.95	0.97	1.02
SD	0.21	0.16	0.14	0.16

The average speed of Group 1 in the first series was 0.88 m/s. The highest speed was achieved by Michał – 1.17 m/s. In the second series, Kristina had the best result with a speed of 1.12 m/s, and the group's average speed was 0.95 m/s. The third series also belonged to Kristina, who achieved the best result of 1.11 m/s, while the overall group average speed in the third series was 0.97 m/s. In the fourth series, Mariusz showed the best speed – 1.16 m/s, and the group's average speed was 1.01 m/s. Among the entire group, the best performers with the increasing speed were Mariusz and Jagoda. In the four series, Jagoda's average speed was 0.85 m/s, while Mariusz's was 0.73 m/s.

Results obtained by the participants in IV intensity [ss], [SR], [SL], [SI] in two attempts of the 4x25 m marching test (Table 5).

Based on the conducted Wilcoxon test for two independent groups, it is possible to make a conclusion that the differences in [ss], [SR], [SL], [SI] at IV highest intensities in the two studies of the 4x25 meters marching test are not statistically significant.

Summary and discussion.

From the analysis of the results of the research that we carried out; it is possible to make a conclusion that the majority of participants improved their performance in the second 4x25 meters marching test in the backstroke style. Some changes in time [s], speed [m/s], stroke length [SL], stroke rate [SR], and stroke index [SI] are significant, but it cannot be definitively attributed to the use of an unconventional equipment during training, as both groups – Group 1, swimming with cotton gloves, and Group 2, swimming without an unconventional equipment – improved their results. Students of this age demonstrate a strong desire to compete with each other, striving to be the best in every aspect and every start. This became evident during the first 4x25 meters marching test on backstroke, where the results of the four intensities of almost every participant are very close to the last maximum intensity, or the first intensity was better than the last. The test was not carried out to the end with a progressively increasing intensity, as was intended in this test. Based on the conducted Wilcoxon test for two independent groups, it can be concluded that the differences in IV highest intensities [ss], [SR], [SL], [SI] are not statistically significant.

The use of an unconventional equipment during training brought participants a lot of joy and new experience. Students eagerly attended the technical training sessions conducted during

Table 5

Results obtained by the participants in two attempts of the 4x25 m marching test. Wilcoxon test of significance differences

PARTICIPANTS	TESTING 1				TESTING 2			
	4 $[v_p]$ [m/s]	4 [SR] [c/min]	4 [SL] [m]	4 [SI] [m·m/s]	4 $[v_p]$ [m/s]	4 [SR] [c/min]	4 [SL] [m]	4 [SI] [m·m/s]
Michał K.	1.14	46.1	1.48	1.69	1.21	58.0	1.25	1.51
Kristina A.	1.06	42.4	1.50	1.59	1.16	52.2	1.33	1.54
Mariusz G.	1.16	54.2	1.28	1.48	1.14	53.4	1.28	1.46
Jagoda N.	0.96	42.0	1.37	1.31	1.15	51.9	1.33	1.53
Maja T.	0.77	38.9	1.19	0.91	0,.99	42.2	1.41	1.39
$\bar{x}$	1.02	44.7	1.36	1.40	1.13	51.5	1.32	1.49
SD	0.16	5.88	0.13	0.31	0,08	5.77	0.06	0.06
Natalia K.	1.10	40.0	1.65	1.81	1.10	40.0	1.65	1.81
Fabian S.	0.97	41.8	1.39	1.35	1,23	45.3	1.63	2.00
Tymek M.	1.01	37.5	1.62	1.64	0.99	41.8	1.42	1.40
Magda K.	1.00	39.3	1.53	1.53	1.08	43.2	1.50	1.62
Igor B.	1.00	44.7	1.34	1.34	0.90	44.0	1.23	1.11
$\bar{x}$	1.02	40.7	1.51	1.53	1.06	42.7	1.49	1.59
SD	0.04	2.73	0.14	0.20	0.12	2.04	0.17	0.35

n.s. – not statistically significant

the research. Did the use of gloves affect the backstroke swimming technique? The time results demonstrated by the participants in the second test improved significantly, the 4x25 meters marching test was performed according to the set criteria, with a gradually increasing intensity. The majority of the participants improved their swimming speed as shows the increase in the overall group average, where:

I Test 4 x 25 – average speed intensity 4: 1.02 [m/s];

II Test 4 x 25 – average speed intensity 4: 1.13 [m/s].

The swimming frequency also increased due to the higher swimming speed:

– I Test 4 x 25 – average stroke rate: 44.7 [strokes/min];

– II Test 4 x 25 – average stroke rate: 51.5 [strokes/min].

The average cycle length decreased due to the increased stroke rate of the participants:

– I Test 4 x 25 – average cycle length: 1.36 [sec/cycle];

– II Test 4 x 25 – average cycle length: 1.34 [sec/cycle].

However, the stroke index of the participants increased:

– I Test 4 x 25 – average stroke index: 1.40 [dimensionless];

– II Test 4 x 25 – average stroke index: 1.49 [dimensionless].

Based on the analysis of the results of the performed research, the conclusion that cotton gloves had a slight impact on the improvement of swimming technique was made. They were merely an "encouragement" for regular attendance at training sessions, providing a new experience and better water feel, and the use of unconventional equipment during training sessions. The major impact was connected with regular backstroke technical training sessions. Analyzing the research results, we came to conclusion that cotton gloves did not have a significant impact on the length of the arm cycle since it decreased in the II Test 4x25 m. The length of the arm cycle is a qualitative component of speed. The value achieved depends on the most challenging aspect for training, the so-called "water feel", combined with the propulsive force of the swimmer's limbs, which is very difficult to achieve at this age. Swimmers learn water feel over the years, as it cannot be achieved in a short time.

The relationship between swim frequency and the cycle length means that if one increases, the other decreases. This was observed with the participants, whose average swim frequency increased in the II Test 4x25 m, but the cycle length decreased. Based on the conducted research, it is possible to claim that proper exercise selection has a significant impact on backstroke swimming, as a proper range of exercises and the coach's knowledge can correct even the smallest technical shortcomings of the swimmer. Unfortunately, it is not easy to achieve, as the coach must have an individual approach to each athlete and the ability to identify and eliminate mistakes in training. The inability to adapt exercises to swimmers can result in the deepening and widening of technical errors, which will become even harder to correct over the years. A wide range of exercises and the use of unconventional equipment during training sessions can greatly diversify activities, and often mundane exercises for swimmers can become enjoyable.

Based on the conducted research, we believe that the age and commitment of students have a significant impact on the results achieved during the 4x25 m test. During the research and training sessions, a division into three groups within the class was noticeable: Group 1 – students with a strong desire to compete, Group 2 – indifferent individuals, and Group 3 – lazy students.

The first group was characterized by great zeal to become better and faster than their peers swimming beside them; after losing a length, arguments, shouting, mutual blaming, and even crying occurred. The second group consisted of students who completed all the tasks but without much attention to swimming technique or speed. The third group was composed of students without motivation, often with slight overweight. Students aged 10–11 have a great desire to compete, striving to be the best among their peers, and often don't pay much attention to the technical execution of exercises. However,

there are apathetic students who assume that they will not succeed and therefore refrain from competing with others.

Conclusions. Based on the analysis of the results of the performed research, the conclusion that cotton gloves had a slight impact on the improvement of swimming technique was made. They were merely an "encouragement" for regular attendance at training sessions, providing a new experience and better water feel, and the use of unconventional equipment during training sessions. The major impact was connected with regular backstroke technical training sessions.

The results showed that most participants improved their backstroke swimming performance in the second 4x25 m timed test. Some changes in times, speed, stroke length, stroke rate, and technique index were significant. However, it is impossible to attribute these improvements solely to the use of unconventional equipment during training because both groups, Group 1 using cotton gloves and Group 2 without unconventional equipment, improved their results, which were not statistically significant in both groups. In conclusion, after analyzing the research topic and answering the research questions, one main conclusion can be drawn: age, commitment, appropriate exercise selection, and varied training sessions have a significant impact on improving a swimmer's technical abilities.

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