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**Divers recovery methods during the competitive period**Iryna Sobko \*<sup>ABCD</sup>, Mykhailo Shevchenko <sup>ABCD</sup>

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**Abstract**

<b>Background and purpose</b>	Due to the high loads of skilled underwater swimmers during the competitive period, the use of recovery means to improve the functional capabilities of athletes is of particular importance. Purpose: To experimentally test the recovery methodology in the competitive period of swimmers specialising in bilast and monolast swimming based on the use of sauna, taping and massage.
<b>Material and methods</b>	10 diving swimmers aged 18-20 years (males), who have the title of master of sports, who train in the swimming pool "Kupava", Brovary. The experiment was conducted from January to May 2023. Swimmers were divided into two groups depending on their specialisation: swimming with a monolast and swimming with a bilast. Methods: theoretical analysis of scientific literature, testing of "Surface Flipper Swimming (SF)", "Bi-flipper Swimming (BF)" at distances of 50 metres during the competition period.
<b>Results</b>	As a result of the experiment, athletes specialising in swimming with a monofin significantly reduced the time of swimming the distance ( $p < 0.05$ ) in the test "Surface Flipper Swimming (SF)", as a result of testing "Breathless Swimming (BF)", a significant improvement in the results of athletes was not revealed. The presented method allows to significantly improve the functional state of the neuromuscular apparatus, preparing the swimmers' organism for repeated physical loads, because the cyclic muscular activity in swimming in fins makes particularly high demands on the cardiovascular system, and special performance clearly correlates with the characteristic of functional abilities of the heart of qualified athletes
<b>Conclusions</b>	The results of the study confirmed the effectiveness of the use of combined methods of recovery in the competitive process of qualified scuba divers, based on the use of sauna, massage, taping.
<b>Keywords</b>	swimming, monolastics, bilastics, recovery, sauna, massage, taping

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## Анотація

Собко І., Шевченко М. Методи відновлення плавців-підводників протягом змагального періоду

<b>Обґрунтування і мета</b>	У зв'язку з великими навантаженнями кваліфікованих плавців підводників протягом змагального періоду особливого значення набуває використання відновлюваних засобів для підвищення функціональних можливостей спортсменів. Мета: експериментально перевірити методику відновлення у змагальному періоді плавців, які спеціалізуються на плаванні з біластом та моноластом, на основі використання сауни, тейпування та масажу.
<b>Матеріал і методи</b>	10 плавців-підводників віком 18-20 років (юнаки), які мають звання майстрів спорту, що тренуються в басейні «Купава», м. Бровари. Експеримент проводився у період з січня по травень 2023 року. Плавці були розділені на дві групи в залежності від їх спеціалізації: плавання з моноластом та плавання з біластом. Методи: теоретичний аналіз наукової літератури, тестування «Поверхнєве плавання на ластах (SF)», «Плавання в біластах (BF)» на дистанціях 50 метрів протягом змагального періоду.
<b>Результати</b>	У результаті проведення експерименту у спортсменів, які спеціалізуються у плаванні з моноластом, достовірно зменшився час пропливання дистанції ( $p < 0,05$ ) у тесті «Поверхнєве плавання на ластах (SF)». В результаті проведення тестування «Плавання в біластах (BF)» достовірного покращення результатів спортсменів не виявлено. Представлена методика дозволяє значно покращити функціональний стан нервово-м'язового апарату, готуючи організм плавців до повторних фізичних навантажень, адже м'язова діяльність циклічного характеру у плаванні в ластах висуває особливо високі вимоги до серцево-судинної системи, а спеціальна працездатність чітко корелює з характеристикою функціональних здібностей серця кваліфікованих спортсменів
<b>Висновки</b>	Результати дослідження підтвердили ефективність використання комбінованих методів відновлення у змагальному процесі кваліфікованих плавців-підводників, на основі застосування сауни, масажу, тейпування.
<b>Ключові слова</b>	плавання, моноласт, біласт, відновлення, сауна, масаж, тейпування

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## Introduction

The development of underwater swimming in Ukraine is gaining momentum, marked by the increasing professionalism of athletes and the growing interest in this sport among the youth [1]. In the process of preparing athletes for high-level competitions, coaches face the challenge of organizing the recovery and training process correctly, particularly, regulating the load while performing water exercises. Swimmers specializing in monofin and bifen swimming have different ages, levels of preparation, and individual characteristics [2]. The most rational approach is to structure the load parameters throughout the entire preparation period, which ensures a gradual improvement of the athlete's sports form and the team as a whole [3,4]. The recovery process has been dedicated to a significant number of scientific works, and there are many methods and their variations. The selection of optimal approaches is critically important for achieving high sports results in underwater swimming. Choosing an effective and less resource-intensive methodology not only contributes to the improvement of athletes' performance but also allows for maintaining their high level of preparedness without excessive resource expenditure. In this way, the preparation process can be optimized, focusing on the quality implementation of training tasks, which, in turn, will contribute to athletes achieving high results in competitions [5,6].

Considerable attention is being paid to the use of sauna, massage, taping and aromatherapy as the main means of recovery in flipper swimming and other sports [7]. These methods are widely documented for their potential to optimize recovery, increase performance and minimize the risk of injury. The literature emphasizes the importance of these recovery techniques in promoting muscle relaxation, reducing inflammation and controlling pain, allowing swimmers to effectively recover energy, combat fatigue and maintain peak performance levels [8].

Given the increased responsibility of fins coaches for achieving and maintaining effective fitness during competitions, it is very important to optimize the training process to improve physical

condition and maximize performance. In the context of expanding program support for athletes, optimizing their training related to improving their physical condition and achieving and maintaining high fitness is of great importance. The intensification of training sessions for swimmers who need to recover quickly after exertion is an important factor related to the objective reasons for the intensification of training sessions and the training process in general [8,9]. The increase in the number of short distances in the competitive program, along with the general increase in the intensity of the training process, requires significant loads on the vital functional systems of the swimmers' body [10,11]. Therefore, the nutritional improvement of various modernization features during the qualification period of swimmers wearing fins is of current importance [12].

Purpose: to experimentally test the methodology of recovery during the competitive period of swimmers specializing in swimming with bilast and monolast, based on the use of sauna, taping and massage.

## Material and methods

### Participants

Participants: 10 athletes aged 18-20 years (boys), holding the titles of Masters of Sport and Candidates, who train at the "Kupava" swimming pool located at 10, Taras Shevchenko Street, Brovary, Kyiv region. The "Kupava" pool meets the necessary standards and requirements for competition hosting; it features 8 lanes, is 50 meters in length with an allowable deviation from 0.03 to minus 0.00 meters, and has a depth of 1.80 meters. Starting blocks are situated on both sides of the pool, ensuring proper conditions for competition and measurements. The pool has been approved by the federation for hosting competitions.

All participants have consented to participate in the experiment. Technical means for measurements included the OMEGA timing system, an audible signal for starting, and a stopwatch for additional time control.

### Procedure

The study spanned from January 7, 2023, to May 23, 2023. Participants were divided into two

groups depending on the type of fins used: monofins (5 individual) and bifins (5 individuals). Swimming with monofin or bifins involved movement on the surface or underwater, utilizing only the swimmer's muscular strength, without the use of supports or any mechanism. Each measurement included registering the reaction time to the auditory signal, the time taken to cover the distance, and analyzing the technical characteristics of the participants' swimming.

The testing procedure encompassed five series of measurements:

1st measurement – January 7, 2023, before the Ukraine Cup;

2nd measurement – February 11-14, 2023, during the Ukraine Cup;

3rd measurement – March 25, 2023, control measurement post two intensive weeks;

4th measurement – May 13, 2023, after two intensive weeks;

5th measurement – May 20-23, 2023, during the Ukraine Championship.

Segmental massage was performed by athletes independently after the morning training twice a week — on Wednesday and Saturday, each session lasting 15 minutes. The process commenced with a 2-minute preparation: athletes assumed a comfortable position, sitting or lying down, and executed deep inhalations and exhalations to achieve a state of relaxation. Then, a 3-minute warm-up was conducted, which included light stroking and kneading of the selected body segment with the convex part of the palm or fingers, moving along the muscle fibers. The main part of the massage lasted 7 minutes and entailed kneading muscles with stronger motions, pressing with the fingertips or edges of the palms with light pressure, and kneading with the convex part of the palm or fingers with light pressure, primarily along the muscle fibers. The subsequent 2 minutes were dedicated to gentle muscle stretching and joint mobilization. The massage concluded with a 1-minute return to light stroking motions to improve circulation and relaxation. Upon the completion of each session, athletes assessed their sensations, focusing on improved mobility and reduced pain. This process was repeated in each of the selected segments for massage, and it was preferable for athletes to perform the massage under the supervision of a massage specialist or physiotherapist, especially

in the initial stages, to ensure correct execution of techniques and to avoid possible injuries [13,14].

### **Taping Procedure**

Taping was carried out once a week by professional kinesiologists. During the taping process, functional diagnostics were used to determine the condition of the athletes' muscles and joints. Different types of tapes could be used depending on the need: rigid tapes for support, elastic tapes for less rigidity, and kinesiology tapes for dynamic muscle function support. Specific diagnostic tests and tools could include assessment of range of motion, muscle strength, joint stability, and other parameters important for swimmers[15].

### **Sauna Recovery Procedure**

The sauna recovery procedure was designed to optimize the athletes' recovery process after intensive training sessions. Firstly, before entering the sauna, athletes took a warm shower to cleanse the skin and prepare the body for the temperature change. The temperature in the sauna was set between 80 to 100 degrees Celsius. The first sauna session lasted 15 minutes. Athletes were positioned on benches, focusing on deep breathing and relaxation. Around the 7-8 minute mark of the session, water with added eucalyptus and mint essential oils (10-15 drops per 500 ml of water) was poured onto the sauna stones. After the first session, athletes went through a cooling process, taking a cold shower for 1-2 minutes, followed by a 5-10 minute rest while replenishing fluids with water or sports drinks. The second sauna session also lasted 15 minutes, with a similar stone-watering process with aromatic oils, and 2-3 more sessions were carried out following the same scheme. After each session, cooling and a 5-10 minute rest followed. After the last sauna session, athletes took a cool or warm shower to return the body temperature to normal, then rested for another 15-20 minutes, continuing to drink water or sports drinks. There was also an opportunity for segmental massage in the steam room. This process allowed athletes to further relax the muscles post-training. After concluding the sauna sessions, athletes rested while consuming herbal tea for better recovery and relaxation [16,17].

## Athlete Preparation Testing Methods

### 1. Surface Finswimming (SF), s:

Surface finswimming (SF) was conducted allowing only a 15-meter submersion after the start and after each turn, with the requirement that the snorkel or swimmer's head emerged from the water by the end of the 15-meter zone. Beyond the 15-meter zone, a part of the swimmer or equipment must always appear on the water surface. All swimmers are required to use a breathing tube continuously across all distances.

### 2. Bi-fins Swimming (BF), s:

Bi-fins swimming (BF), with the swimming style being breaststroke crawl with a tube, was conducted while continuously breathing across all distances. Dolphin swimming is allowed only within 15 meters in apnea after the start and each turn. Submersion is allowed only within 15 meters after the start and each turn, with the requirement that the snorkel or swimmer's head emerged from the water before the end of the 15-meter stretch.

## Statistical analysis

Mathematical statistics methods using SPSS and Microsoft Excel programs were used in the study. Such indicators as arithmetic mean, root mean square deviation, error of representativeness and Student's t-test for paired samples were determined.

## Results

At the beginning of the study, the control group of athletes was tested for normal distribution. It was found that according to the indicators of physical fitness testing there is no significant difference ( $p > 0.05$ ) of the subjects from the normal distribution, and therefore it is possible to use statistical data for calculations in this group (Table 1)

Table 2 shows that there is no significant difference ( $p > 0.05$ ) of the subjects specializing in swimming with a bilast from the normal distribution, and therefore it is possible to use statistical data for calculations in this group of sportsmen.

Table 3 presents the results of surface swimming on fins (SF), (c) of the group of sportsmen specializing in swimming with a monofin ( $n = 5$ ) during the experiment. As a result of the experiment in athletes who specialise in swimming with a monofin flipper, significantly decreased the time of swimming distance ( $p < 0.05$ ) in the test Surface «Swimming on Flippers (SF)». This can be explained by an increase in the efficiency of swimming technique and optimisation of movements, which, in turn, led to a reduction in the time required to complete the distance. The use of sauna during the experiment helped to reduce muscle tension and improve blood circulation in the athletes. In addition, the recovery methods used during the experiment may contribute to the improvement of endurance and strength.

Table 4 presents the results of surface swimming on flippers (BF), (c) of the group of sportsmen specializing in swimming with a bilast ( $n = 5$ ) during the experiment. After the study, these athletes did not show a statistically significant improvement in the three measurements during the experiment.

Thus, the great importance and constantly growing capabilities for the essential activity of swimmers necessitate the need for the immediate improvement of various modernization features to enhance the performance of the body.

The presented methodology makes it possible to significantly improve the functional state of the neuromuscular apparatus, preparing the organism of swimmers for repeated physical loads. It can be noted that the timely alternation of physical means of recovery of different orientation allows to increase the efficiency of management of recovery processes of the athlete's organism. The results of the conducted researches testify to the high efficiency of this approach allowing to improve the quality of the training process both in the period of intensive preparation for competitions and during competitions, which preserves a high level of functional capabilities of swimmers in fins to increase sports achievements.

Table 1

The results of testing the hypothesis on the normality of the distribution of athletes specializing in monolastics swimming (n = 5)

Test *		1	2	3	4	5
Normal parameters a,b	$\bar{x}$	15.50	9.17	7.83	4.67	6.82
	S	1.38	1.17	0.98	0.82	0.07
Differences of extremes	Module	0.20	0.22	0.30	0.29	0.27
	Positive	0.20	0.22	0.30	0.29	0.27
	Negatives	-0.20	-0.16	-0.22	-0.21	-0.20
Statistics		0.20	0.22	0.30	0.29	0.27
Asymptotic value (two-sided)		0.200c,d	0.200c,d	0.094c	0.117c	0.199c
Monte Carlo value						
value		0.941e	0.865e	0.553e	0.591e	0.692e
Lower limit		0.94	0.86	0.54	0.58	0.68
Upper limit		0.95	0.87	0.57	0.60	0.70

Notes: \* - the dates of the measurements are described in the section "Research methods

a. The tested distribution is normal.

b. Calculated from the data.

c. Lilliefors significance correction.

d. This is the lower bound of true significance.

e. Based on a sample of 10,000 tables with the original value of 1122541128

Table 2

The results of testing the hypothesis on the normality of the distribution of athletes specializing in belastics swimming (n = 5)

Test *		1	2	3	4	5
Normal parameters a,b	$\bar{x}$	22,35	22,37	24,12	23,02	22,08
	S	1,97	1,98	2,23	1,89	1,91
Differences of extremes	Module	0,31	0,34	0,31	0,34	0,25
	Positive	0,31	0,34	0,31	0,34	0,22
	Negatives	-0,25	-0,25	-0,24	-0,25	-0,25
Statistics		0.20	0,31	0,34	0,31	0,34
Asymptotic value (two-sided)		0,122c	0,069c	0,119c	0,067c	0,200c,e
Monte Carlo value		0,609d	0,503d	0,604d	0,475d	0,840d
value		0.941e	0,59	0,49	0,59	0,46
Lower limit		0.94	0,62	0,51	0,61	0,48
Upper limit		0.95	22,35	22,37	24,12	23,02

Notes:

\* - the dates of the measurements are described in the section "Research methods

a. The tested distribution is normal.

b. Calculated from the data.

c. Lilliefors significance correction.

d. This is the lower bound of true significance.

e. Based on a sample of 10,000 tables with the original value of 1122541128

Table 3

Indicators of surface finning (SF), (c) groups of athletes specializing in monofin swimming (n = 5) during the experiment

Statistics of paired samples	Measurement	Statistical indicators				
		$\bar{x}$	S	m	t	p
1 pair	To the experiment	19,07	0,71	0,31	0,86	0,43
	at the Cup of Ukraine	18,91	0,9	0,4		
2 pairs	at the Cup of Ukraine	18,91	0,9	0,4	2,17	0,09
	at the Championship of Ukraine	18,12	0,13	0,06		
3 pairs	To the experiment	19,07	0,71	0,31	3,46	0,02
	at the Championship of Ukraine	18,12	0,13	0,06		

Table 4

Indicators of Bi-fins Swimming (BF), (c) groups of athletes (n = 5) during the experiment

Statistics of paired samples	Measurement	Statistical indicators				
		$\bar{x}$	S	m	t	p
1 pair	To the experiment	22,35	1,97	0,88	-0,44	0,67
	at the Cup of Ukraine	22,37	1,98	0,88		
2 pairs	at the Cup of Ukraine	22,37	1,98	0,88	1,66	0,16
	at the Championship of Ukraine	22,08	1,91	0,85		
3 pairs	To the experiment	22,35	1,97	0,88	2,06	0,10
	at the Championship of Ukraine	22,08	1,91	0,85		

## Discussion

Modern sport science has many sport science has a lot of data on the mechanisms of recovery processes recovery processes, peculiarities of their flow in different sports[7,18]. However, in the opinion of many of many specialists, this problem in underwater sport is far from its final solution[19].

Analysis of scientific and methodological literature showed the effectiveness application of traditional means and methods in training submarine swimmers. At the same time, in modern science there is a clear lack of work devoted to the training of swimmers with fins [20,21]. There is also a clear lack research using non-traditional means and methods, in particular, means of modern health technologies in the training of submarine swimmers. The analysis of the received results of experiment has allowed

to confirm the earlier put forward hypothesis that application of physical means of restoration in training and competitive activity allows differentiated influence on a functional condition of the athlete. The variation in the rate of recovery from exercise is significant, with some authors suggesting that it is largely genetically determined and depends on well-organized training programs. Previous studies have shown that the use of specialized training programs for athletes with different anthropometric data contributes to a more effective improvement of all functional systems, improving the recovery of all vital functions after competition [22]. Under the influence of such training programs, the reserve and adaptive capabilities of swimmers increase, which has a positive effect on their performance and contributes to a faster achievement of peak fitness.

In a study conducted by [23], the effect of ankle taping on undulating underwater swimming was investigated. They observed a significant decrease in swimming speed after applying ankle taping, which affected the rotation of the swimmer's forefoot during the downward stroke, which is crucial for forward propulsion. In another study [24], examined the effectiveness of kinesiological taping on shoulder flexibility and pain in swimmers. After applying kinesiological taping, there was a marked improvement in shoulder flexion as well as a significant reduction in shoulder pain and disability scores, suggesting that kinesiological taping can improve shoulder mobility and relieve pain, contributing to better performance in swimmers. In a study [17] investigated the effect of a post-workout sauna on swimming performance recovery. The study showed that after visiting the sauna, swimmers performed worse, increasing the time by +1.69 seconds compared to a decrease of -0.66 seconds in placebo conditions.

The deterioration in performance was most pronounced in the first 50 m, indicating that visiting a sauna after training may not be very useful for recovery of swimming performance, especially when high-intensity training or competition is planned for the next day. This is a very important finding for athletes and coaches who consider the sauna as a

recovery intervention [24,25].

Thus, the use of various recovery methods has shown promise in helping athletes overcome the physical challenges associated with high-intensity training and competition. Methods such as kinesiological taping and sports massage, as shown by research by significant potential in improving joint mobility, reducing discomfort, and increasing post-exercise lactate clearance [23]. These findings underscore the collective efforts of the sports science community to optimize athletic performance and accelerate recovery to meet the high demands of flipper swimming and related water sports

## Conclusions

The results of the study confirmed the effectiveness of the use of combined methods of recovery in the competitive process of qualified scuba divers, based on the use of sauna, massage, taping.

## Conflict of interest

The authors declare that there is no conflict of interest.

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