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# Adaptive swimming as a means of physical and sports rehabilitation for people with musculoskeletal disorders

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## ABSTRACT

**Aim:** To investigate the impact of adaptive swimming training sessions on the psycho-emotional and functional state of individuals with musculoskeletal disorders.

**Materials and Methods:** The research was conducted in 2025, with 32 male service members aged 26-58 who underwent rehabilitation for musculoskeletal injuries over 6 weeks. The research used a combination of theoretical, empirical, and mathematical statistical methods. The psycho-emotional state was assessed using the Wessman-Ricks technique, and the functional state was assessed using a 100 m swimming test and the duration of heart rate recovery after exercise.

**Results:** Data analysis showed that adaptive swimming training sessions have a pronounced rehabilitative effect: they normalize the psycho-emotional state, reduce stress levels, and increase the body's adaptive capabilities. The integral indicator of emotional state after 6 weeks of training increased by 1.15 points ( $p \leq 0.001$ ) and reached a good level, reflecting the restoration of emotional balance. Functional indicators also improved: the time to cover a distance of 100 meters was reduced by 51 seconds ( $p \leq 0.001$ ); the duration of heart rate recovery was reduced by 3.65 beats per minute ( $p \leq 0.001$ ).

**Conclusions:** It has been established that adaptive swimming training sessions contribute to improving the psycho-emotional state and functional capabilities of individuals with musculoskeletal disorders. A significant improvement in the integral indicators of the cardiovascular system's emotional and functional states has been observed.

**KEYWORDS:** adaptive swimming, adaptive sports, service members, health, musculoskeletal system, psycho-emotional state, functional state, physical education and sports rehabilitation

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## INTRODUCTION

The modern needs for rehabilitation of people with musculoskeletal disorders and the development of scientifically based approaches to restoring the body's functional capabilities necessitate the active introduction of adaptive physical culture and sports. In this regard, adaptive swimming occupies a special place, as it offers significant potential for health, rehabilitation, and social integration thanks to the unique properties of the aquatic environment [1-3].

Adaptive swimming is used in both medical and rehabilitation practice and in the adaptive sports system, thereby improving the quality of life of people with various nosologies, in particular musculoskeletal disorders [4, 5]. At the same time, this type of motor activity is considered a form of physical education and sports in the aquatic environment, specially adapted to the functional capabilities of people with musculoskeletal disorders, taking into account the nature, degree, and location of the damage. Its key features include individualized physical activity, modification of movement techniques, the use of special

aids (belts, noodles, boards, floats), and a combination of health, rehabilitation, and sports activities [6-9].

The health and rehabilitation effects of adaptive swimming are mainly due to the properties of the aquatic environment, which creates specific conditions for the motor activity of people with musculoskeletal disorders [10-12]. These include: reduction of the effects of gravity, which makes it possible to perform exercises without excessive strain and helps to reduce pain; optimization of axial load (thanks to the buoyancy of water, the load on the musculoskeletal system is reduced, which is extremely important in cases of impaired support and gait); water resistance, which ensures uniform load on muscle groups without the risk of overload; hydrostatic pressure, which has a positive effect on blood circulation, lymphatic drainage, and the functional state of the cardiovascular system; thermal effect of water, which promotes muscle relaxation and pain reduction [13-15].

The relevance of adaptive swimming in the rehabilitation of people with musculoskeletal disorders has sparked growing scientific interest, reflected in a significant number

of contemporary domestic and international studies. A review of the scientific literature shows that the problem of rehabilitation of people with musculoskeletal disorders is relevant in most countries worldwide, as the effectiveness of such measures directly affects the level of social integration, psycho-emotional state, and physical health of this category of the population [2, 4].

In modern scientific works, adaptive swimming is considered an essential component of comprehensive medical and physical rehabilitation programs, which contributes to the restoration of motor functions, reduction of contractures, improving coordination, normalizing muscle tone, and forming compensatory motor skills in people with musculoskeletal disorders, particularly after spinal injuries and amputations [5]. Scientists [16-18] note that training sessions in the aquatic environment activate the cardiovascular and respiratory systems, strengthen the muscle corset, reduce muscle hypertonicity, and create a relaxing effect that helps reduce the impact of stress.

At the same time, several studies emphasize the need for further scientific justification of methodological approaches to organizing adaptive swimming training sessions, taking into account the nosological specificity and functional state of persons undergoing rehabilitation [2, 19]. Despite the growing number of scientific works on the use of adaptive physical culture in the rehabilitation of people with musculoskeletal disorders, the results of these studies remain fragmentary. Most studies focus primarily on the physiological aspects of motor function recovery. At the same time, the impact of adaptive swimming training sessions on the psycho-emotional state, motivation for physical activity, and overall well-being of individuals with musculoskeletal disorders is insufficiently covered [20, 21]. In addition, existing studies do not always take a comprehensive approach to assessing the effectiveness of adaptive swimming, failing to integrate analyses of individuals' functional and psycho-emotional states in the rehabilitation process.

Modern concepts of rehabilitation emphasize the need for a systematic impact on the human body, encompassing not only the restoration of motor functions but also the improvement of the psycho-emotional state, the development of positive motivation for physical activity, and an increase in the overall quality of life [1, 6, 22]. In view of this, adaptive swimming is considered a promising means of physical and sports rehabilitation, capable of providing a comprehensive positive effect through a combination of physical, psycho-emotional, and social factors. At the same time, this necessitates further scientific research aimed at a detailed study of the impact of adaptive swimming training sessions on the bodies of people with musculoskeletal disorders, taking into account both functional and psycho-emotional indicators.

## AIM

The aim is to investigate the impact of adaptive swimming training sessions on the psycho-emotional and functional state of individuals with musculoskeletal disorders.

## MATERIALS AND METHODS

### PARTICIPANTS

The research, conducted in 2025, involved 32 service members aged 26 to 58 who were undergoing rehabilitation after musculoskeletal injuries (traumatic and functional disorders of the spine and joints). Based on the decisions of a multidisciplinary rehabilitation team, these individuals were recommended to undergo physical and sports rehabilitation, including adaptive sports, particularly adaptive swimming.

Rehabilitation measures were carried out at rehabilitation centers in Zhytomyr, and adaptive swimming training sessions were conducted at the "Avangard" sports complex (25 m indoor pool) three times a week for 45 minutes. The results were processed and analyzed at the Department of Physical Education and Sports Rehabilitation of the S. P. Koroliov Zhytomyr Military Institute (ZMI). All training sessions were conducted under medical supervision and with the participation of rehabilitation specialists. The criteria for inclusion of participants in the research were determined as follows: male service members who had participated in combat operations and suffered injuries and damage to the musculoskeletal system (spinal injuries) were included in the research; after treatment, the service members were prescribed adaptive swimming as a means of physical and sports rehabilitation; absence of diseases and contraindications due to health conditions (chronic infectious diseases, etc.) to adaptive swimming training sessions. The exclusion criteria were discontinuation of training sessions due to health conditions or other reasons, and the service members' own desire to withdraw from the research at any time. All participants were informed of the research objectives, after which they provided written consent to participate solely for scientific purposes.

### RESEARCH METHODS

The research involved the use of a combination of theoretical, empirical, and mathematical statistical methods. Theoretical methods included analysis and generalization of literary sources. Analysis and generalization of literary sources were used to conduct an analytical review of scientific sources on the outlined range of issues (27 sources from PubMed, Scopus, Web of Science, and Index Copernicus were analyzed).

Empirical methods included methods for assessing the psycho-emotional and functional state of service members. The dynamics of the participants' psycho-emotional state were assessed using the Wessman-Ricks emotional state self-assessment technique, and their functional state was assessed using a swimming test in a pool (100 meters) and analysis of heart rate (HR) recovery 1 minute after the end of the exercise. The testing was conducted twice: at the beginning of the participants' stay at the training base and after 6 weeks of systematic adaptive swimming training sessions.

The level of emotional state was determined based on the results of a survey using an electronic form (Google Forms), in which participants selected the statements that most accurately reflected their current psycho-emotional state. The analysis was carried out using the following

scales: "Calmness – Anxiety," "Energy – Fatigue," "Elation – Depression," and "Self-confidence – Helplessness," each rated on a ten-point scale. The formula determined the integral indicator of emotional state (ES):  $ES = (I_1 + I_2 + I_3 + I_4) / 4$ , where  $I_1$ – $I_4$  are individual indicators on the corresponding scales. ES values within the range of 8–10 points were interpreted as very good, 6–7 points as good, 4–5 points as poor, and 1–3 points as bad.

To assess functional fitness (functional endurance, aerobic working capacity, and cardiovascular system adaptation capabilities), a 100 m swimming test and analysis of HR dynamics 1 minute after the end of the exercise were used. The testing was conducted in an indoor 25 m pool at a water temperature of 27–30°C, which provided safe and comfortable conditions for people with musculoskeletal disorders. Before the test, participants performed a standard five-minute preparatory phase, which included light water movements and breathing exercises. During the test, any method of movement in the water was allowed, taking into account the nature of the injury and the individual's functional capabilities; short-term slowdowns or stops were allowed without leaving the water or stopping the timer. If necessary, buoyancy aids (boards, noodles, belts) were used, and their use was recorded and maintained unchanged during retesting. Retesting was conducted under the same conditions after the completion of the six-week program. Heart rate was recorded using a Garmin Forerunner 165 sports watch and a Garmin HRM-Pro Plus chest strap, which ensured accurate determination of maximum heart rate at the finish and 1 minute after recovery. A reduction in the time taken to cover the distance and a decrease in the duration of heart rate recovery were considered positive changes in functional status.

#### STATISTICAL METHODS

The methods of mathematical statistics were used to process the data obtained. The reliability of the difference between the indicators was determined using the Student's t-test. The results were presented as Mean±m, where Mean is the arithmetic mean, m is the standard error. The reliability of the difference was set at  $p < 0.05$ . All statistical analyses were performed using STATISTICA 6.1 software package (number AGAR909E415822FA), adapted for medical and biological research.

#### ETHICS

The procedure for organizing the study and the topic of the article were previously agreed with the Committee on compliance with Academic Integrity and Ethics of the ZMI. Also this study followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all participants who took part in this study.

#### FRAMEWORK

This scientific article was carried out according to the plan of the research work of the National Academy of Internal Affairs for 2020–2026, "Psychological, pedagogical and sociological support of law enforcement officers" (state registration number 0113U008196).

## RESULTS

Adaptive swimming programs were developed by specialists in physical and sports rehabilitation, taking into account the type and level of spinal (cervical, thoracic, lumbar) and joint injuries, the degree of damage, individual functional capabilities, and motor experience of the persons undergoing rehabilitation. The rehabilitation process was implemented in stages, including functional recovery, training, and adaptation, which ensured a gradual and safe increase in motor activity. The functional recovery stage (1 week) focused on adapting to the aquatic environment, developing proper breathing techniques, reducing muscle tension, and mastering basic water movements. The training and adaptation stage (5 weeks) involved consolidating restored motor functions, increasing physical fitness, and adapting the body to systematic, measured training loads in the aquatic environment.

Depending on the type and degree of injury, the program included a set of corrective exercises aimed at stretching, decompression, and stabilization of the spine (stretching with support on the edge, with a noodle or a float; maintaining a horizontal position, balance exercises, smooth rolls, sliding with body axis control, etc.). Symmetrical and asymmetrical swimming exercises were used during the training sessions. Symmetrical exercises ensured an even distribution of load and the formation of rational movement patterns. In contrast, asymmetrical exercises were aimed at correcting muscle imbalance, activating deep stabilizing muscles, and improving neuromuscular control of movements. Performing exercises in the aquatic environment reduced axial load on the spine and joints, thereby increasing the safety and effectiveness of the rehabilitation. The selection of exercises, their duration, and intensity were determined individually, using support devices (noodles, boards, special floats) to provide additional relief for the spine.

The results of the research show that six weeks of adaptive swimming training sessions have a pronounced rehabilitative effect, manifested in normalization of the psycho-emotional state, reduced stress levels, and increased adaptive capabilities. The dynamics of most indicators are characterized by a change from a poor to a good level, which is one of the key criteria for the effectiveness of rehabilitation programs.

In particular, the increase in the integral ES indicator from  $5.83 \pm 0.13$  to  $6.98 \pm 0.10$  points ( $p \pm 0.001$ ) reflects the restoration of emotional balance and a decrease in manifestations of maladjustment. From a rehabilitation perspective, this indicates a reduction in psycho-emotional stress and activation of internal regulatory mechanisms, which is a necessary prerequisite for further physical and mental recovery (Table 1).

An improvement in the "Calmness-Anxiety" indicator to  $6.59 \pm 0.11$  points ( $p \pm 0.01$ ) indicates a pronounced anxiolytic effect of adaptive swimming. Training sessions in the aquatic environment, combining rhythmic movements, controlled breathing, and sensory relaxation, help reduce anxiety, which is one of the basic tasks of psycho-emotional rehabilitation. A significant increase in the "Energy – Fatigue" indicator

**Table 1.** Dynamics of indicators of the psycho-emotional and functional state of service members with musculoskeletal disorders (n = 32)

Researched indicators	Research stages	Mean±m	Significance of the difference	
			t	p
Psycho-emotional state indicators, points				
Calmness – Anxiety	initial	5.91±0.18	3.22	p≤0.01
	final	6.59±0.11		
Energy – Fatigue	initial	5.75±0.15	4.87	p≤0.001
	final	6.75±0.14		
Elation – Depression	initial	5.84±0.20	5.37	p≤0.001
	final	7.25±0.17		
Self-confidence – Helplessness	initial	5.81±0.15	5.03	p≤0.001
	final	7.19±0.23		
Integral indicator of emotional state	initial	5.83±0.13	7.01	p≤0.001
	final	6.98±0.10		
Functional state indicators				
100 m swimming test, s	initial	310.34±5.53	7.50	p≤0.001
	final	259.44±3.94		
HR recovery time 1 minute after the end of the exercise, bpm	initial	22.44±0.80	3.85	p≤0.001
	final	26.09±0.51		

Legend: Mean – arithmetic mean; m – standard error; t – Student's t-test value; p – p-value

Source: compiled by the authors of this study

from 5.75±0.15 to 7.50±0.14 points (p≤0.001) indicates the restoration of the body's functional reserves. In terms of rehabilitation, this can be interpreted as a reduction in chronic fatigue symptoms, increased tolerance to physical exertion, and improved overall functional status. Positive dynamics on the "Elation – Depression" scale (up to 7.25±0.17 points; p≤0.001) reflect the normalization of the emotional background and an increase in the motivational component. This is of significant importance for the rehabilitation process, as increased elation contributes to greater individual involvement in recovery activities and to the formation of a stable commitment to systematic exercise.

Particularly significant in the rehabilitation aspect is the reliable increase in the indicator on the "Self-confidence – Helplessness" scale to 7.19±0.23 points (p<0.001), which is considered good. This indicates the restoration of psychological self-regulation, a decrease in feelings of helplessness, and the formation of an internal resource for overcoming difficulties, which is a critically important factor for successful social and professional reintegration.

Thus, the improvement in the psycho-emotional state created favorable conditions for the implementation of physiological adaptations caused by systematic motor activity in the aquatic environment. In this regard, it is advisable to analyze changes in the cardiovascular system's functional state, which reflect the effectiveness of the next stage of the experiment.

During the research, the results of a 100-meter swimming test were analyzed, during which the maximum heart

rate was recorded immediately after completing the distance, as well as its recovery indicators 1 minute after the load. At the initial stage, the average time to cover 100 meters was 5 min 10.34 s (310.34±5.53 s), indicating reduced functional endurance and limited cardiovascular adaptive capabilities in individuals with musculoskeletal disorders. After 6 weeks of adaptive swimming training sessions, a statistically significant improvement in results was observed – the average time to cover the distance was reduced to 4 min 19.44 s (259.44±3.94 s) (p≤0.001). The observed positive dynamics indicate a significant increase in functional endurance, driven by the combined effects of the aquatic environment and systematic training. The reduction in the time taken to cover the distance can be explained by improved coordination and efficiency of movement patterns in water, reduced pain and muscle tension due to the unloading effect of water, increased aerobic capacity of the cardiovascular and respiratory systems, and increased tolerance to physical exertion. The results confirm the pronounced rehabilitative effect of adaptive swimming, manifested in increased overall functional readiness and greater opportunities for people with musculoskeletal disorders to participate in everyday physical activity.

Analysis of heart rate recovery 1 minute after exercise also showed positive changes. At the initial stage, the HR reduction was 22.44±0.80 bpm, whereas after completing the training sessions, it increased to 26.09±0.51 bpm, indicating accelerated heart rate recovery. The improvement in HR recovery rate

indicates the activation of parasympathetic regulatory mechanisms, increased cardiac efficiency, and growth in the body's adaptive reserves. In terms of rehabilitation, this is an essential indicator of reduced cardiovascular stress from physical activity and increased safety during motor activity in individuals with musculoskeletal disorders.

## DISCUSSION

Modern rehabilitation approaches to the recovery of individuals with musculoskeletal disorders are based on comprehensive measures, among which adaptive swimming plays a key role. Its effectiveness stems from the unique properties of the aquatic environment, which provide a combination of therapeutic, restorative, and psycho-corrective effects [2, 23].

The results of the research are consistent with scientific literature and confirm the positive impact of adaptive swimming on participants' psycho-emotional state [5, 24, 25]. A significant improvement in the integral ES indicator, along with positive dynamics on selected scales, indicates a reduction in psycho-emotional tension, increased confidence in one's own abilities, and the formation of internal resources for self-regulation. This is crucial for the effectiveness of the rehabilitation process and further social adaptation.

Along with psycho-emotional changes, a significant improvement in aerobic performance was recorded. The reduction in time taken to cover 100 meters after 6 weeks of training indicates increased functional endurance, improved motor skills, and greater tolerance to physical exertion. The uniform involvement of muscle groups can explain these changes, reduced axial load on the joints, and improved coordination of movements in the aquatic environment. The positive dynamics of heart rate recovery 1 minute after exercise indicate an increase in the cardiovascular system's

efficiency and the body's adaptive reserves. Regarding rehabilitation, this confirms the feasibility and safety of the physical exercises performed [26].

The results obtained confirm the advisability of using adaptive swimming as an effective means of comprehensive physical and sports rehabilitation and confirm the conclusions of many scientists [3, 4, 17, 27] regarding the need to individualize programs taking into account the nosology, functional state, and psycho-emotional characteristics of persons undergoing rehabilitation.

## CONCLUSIONS

It has been established that adaptive swimming training sessions have a pronounced rehabilitative effect in individuals with musculoskeletal disorders, manifested in comprehensive improvements in psycho-emotional state and functional capabilities of the body. It has been proven that systematic adaptive swimming training sessions contribute to the normalization of the psycho-emotional state, reduction of anxiety and fatigue, increased confidence in one's own abilities, and motivation to actively participate in the rehabilitation process. A statistically significant increase in functional endurance has been found, as confirmed by a reduction in the time taken to swim a distance of 100 meters ( $p \leq 0.001$ ). Adaptive swimming had a positive effect on the functional state of the cardiovascular system, as evidenced by accelerated heart rate recovery after physical exertion and increased cardiac efficiency ( $p \leq 0.001$ ).

## PROSPECTS FOR FURTHER RESEARCH

We see prospects for further research into the effectiveness of adaptive swimming, taking into account different nosological groups, the duration of rehabilitation programs, and their combination with other physical therapy methods.

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## CONFLICT OF INTEREST

The Authors declare no conflict of interest

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