ORIGINAL ARTICLE

CONTENTS

Physical and sports rehabilitation of patients with amputations using adaptive badminton

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ABSTRACT

Aim: To assess the impact of adaptive badminton training sessions on the functional status, quality of life, and health of patients with amputations.

Materials and Methods: The research conducted in 2025 involved 26 combatants who were in the final stages of their rehabilitation after limb amputations due to blast and shrapnel wounds. The dynamics of functional status, quality of life, and health indicators were determined using the "SF-36 Health Survey" socio-psychological questionnaire and the "WAM" functional status self-assessment method.

Results: A significant improvement in overall physical and psychological health components was observed in patients with amputations as a result of participating in adaptive badminton training sessions. These indicators improved by 5.92 and 6.18 points, reaching 65.06 ± 0.97 and 76.60 ± 0.65 points, respectively. The most pronounced positive changes were recorded in the indicators of physical functioning, vitality, and social functioning. Positive dynamics were also found in the well-being, activity, and mood of the participants in the rehabilitation activities; the overall "WAM" indicator improved by 0.8 points and reached 4.77 ± 0.12 points.

Conclusions: It was established that adaptive badminton have a positive effect on the health and functional status of patients with amputations. The results of the research indicate a significant improvement in the physical and psychological components of health in the study participants. Positive changes in well-being, activity, and mood were also observed among participants in rehabilitation activities, indicating the advisability of wider implementation of adaptive badminton training sessions in physical and sports rehabilitation for combatants.

KEY WORDS: adaptive badminton, health, patients with amputations, physical and sports rehabilitation, functional status, quality of life

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INTRODUCTION

Military aggression and large-scale combat operations have led to a significant increase in the number of military personnel, law enforcement officers, and civilians with limb amputations caused by gunshot and shrapnel wounds [1, 2]. The return of such individuals to a whole life exacerbates the need for effective physical, psychological, and social rehabilitation [3]. In view of the above, physical and sports rehabilitation is essential and effective. It is a system of measures based on physical exercises aimed at restoring and adapting the body's functional capabilities, improving physical and mental health, and overall health [4]. One type of physical and sports rehabilitation is adaptive physical culture and sports. Performing physical exercises during adaptive physical culture training sessions contributes to: the restoration of motor activity; correction of impaired functions; development of new motor skills considering amputations; improvement of psycho-emotional and functional status, and quality of life. Training sessions in adaptive sports are an effective tool for combating stress, post-traumatic stress disorder, anxiety, and social isolation [5, 6].

Analysis of current scientific literature supports the conclusion that adaptive badminton is among the most effective and efficient methods for physical and sports rehabilitation in individuals who have lost limbs or sustained musculoskeletal injuries [7]. This sport is a modified form of classic badminton, aimed at involving people with musculoskeletal disorders, in particular those with limb amputations due to blast and shrapnel injuries. It combines elements of sports training,

physical therapy, and psychological rehabilitation and promotes the restoration of motor skills, balance, cognitive functions, and social integration of participants [8].

Scientists [9] claim that adaptive badminton training sessions activate the vestibular apparatus, sensorimotor connections, and proprioceptive sensitivity; develop concentration, spatial perception, and quick thinking; promote motivation for regular physical activity and reduce pain and anxiety. At the same time, such training sessions require developing the ability to control movement while accounting for changes in biomechanics, since people with amputations may have a shifted center of mass and a different pattern of compensatory movements [10]. The type of amputation determines how badminton is adapted. In particular, for individuals with lower-limb amputations, the emphasis is on stabilizing the body, controlling the center of gravity, using the prosthesis, and developing balance. In the absence of an upper limb, the focus is on learning the correct racket grip (using special cuffs-fasteners), compensating for actions through torso movement, and developing the back muscles. In the case of bilateral amputation, the work is performed while sitting, with emphasis on maintaining a stable pelvic position, making short movements, and developing stroke technique. In cases of combined injuries, a single recovery trajectory is used. [11].

Experts in adaptive sports note that the methodology for teaching adaptive badminton involves mastering the basics of the game; safety rules during training sessions; biomechanical principles of movement and strokes; principles of adapting movements to the type of amputation; methods of self-control and recovery after exercise [12]. Scientists [13] argue that it is essential to develop skills in maintaining proper body position, coordinating movements with the racket and shuttlecock, maintaining balance during movement, executing serves, returns, and basic strokes, and applying breathing and recovery techniques. The training methodology for athletes with amputations in adaptive badminton is based on the comprehensive use of interactive, corrective-rehabilitative, psychosocial, and other methods. The choice of a particular technique depends on the type of amputation, the level of functional preparedness, the phase of the rehabilitation process, and the participant's psycho-emotional state [14].

Scientists [15] are convinced that the introduction of adaptive badminton into rehabilitation programs for people with amputations and musculoskeletal injuries helps expand participants' functional capabilities, promotes faster recovery of physical and mental health, and supports more effective coping with stress. The expected results of implementing such programs include: improvement in static and dynamic balance; restoration of motor control during prosthesis use; development of strength, coordination, and precision of motor actions; formation of basic playing skills and motivation for training; and creation of conditions for social integration through joint motor activity. The need to study the impact of adaptive badminton as a means of physical and sports rehabilitation on the functional state, quality of life, and health of people with amputations made the topic of our research relevant.

AIM

The aim is to assess the impact of adaptive badminton training sessions on the functional status, quality of life, and health of patients with amputations.

MATERIALS AND METHODS

PARTICIPANTS

The research, conducted in 2025, involved 26 combatants (military personnel and law enforcement officers) who were in the final stage of their rehabilitation after lower/upper limb amputations (categories SL and SU) due to blast and shrapnel wounds. Based on the decisions of a multidisciplinary rehabilitation commission, these patients were recommended to undergo physical and sports rehabilitation through adaptive sports, particularly adaptive badminton.

Rehabilitation measures were implemented in rehabilitation centers in Kyiv and the Kyiv Oblast. Adaptive badminton training sessions were conducted at the sports facilities of the National Academy of Internal Affairs (NAIA) three times a week. The results were processed at the Department of Special Physical Training of the NAIA and the Department of Physical Education and Sports Rehabilitation of S. P. Koroliov Zhytomyr Military Institute. Training sessions were conducted under medical supervision and accompanied by rehabilitation specialists.

RESEARCH METHODS

The research employed a range of theoretical, empirical, and statistical methods. The dynamics of functional status, quality of life, and health indicators were determined using the "SF-36 Health Survey" socio-psychological questionnaire [16] and the "WAM" functional status self-assessment method [17]. The participants were tested upon arrival at the training bases of the educational institutions and after 10 weeks of systematic training. According to the methodology for assessing

quality of life and health indicators, participants in rehabilitation activities must answer 36 questions from the "SF-36 Health Survey" questionnaire. The assessment was conducted by comparing pre- and post-course results from adaptive badminton training sessions. The methodology does not provide for normative or critical values. For each item, several answer options are offered, which are scored from 0 to 100 points. A score of 0 indicates the worst possible quality of life, and 100 indicates the highest. The results are presented across eight scales, grouped into two areas that determine the components of physical and psychological health. The Physical Health (PH) component comprises the following indicators: Physical Functioning (PF), Role-Physical (RP) Functioning, Bodily Pain (BP), and General Health (GH). The Mental Health (MH) component includes the following indicators: Vitality (VT); Social Functioning (SF); Role-Emotional (RE) Functioning; Mental Health (MH) [16].

The "WAM" functional status self-assessment method is designed to assess well-being, activity, and mood quickly. According to the instructions, you need to compare your condition with a series of signs on a multi-step scale. The scale includes indices (3 2 1 0 1 2 3). It is located between thirty pairs of statements that are opposite in meaning and reflect mobility, speed, and pace of functions (activity), strength, health, fatigue (well-being), as well as characteristics of emotional state (mood). The test participant should choose the number that most accurately reflects their current state. The processing and interpretation of the results obtained involves decoding the answers. In particular, index 3, which corresponds to poor well-being, low activity, and bad mood, is taken as 1 point; index 2 is taken as 2 points; index 1 is taken as 3 points, and so on up to index 3 on the opposite side of the scale, which is equal to 7 points. Positive functional status is assessed with high scores, whereas negative functional status is assessed with low scores. Based on the points obtained, the arithmetic mean is calculated for the overall score and separately for activity, well-being, and mood [17].

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 $X \pm m$, where X 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 NAIA. 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

The results of the study of the dynamics of the indicators of the physical and mental components of health and the functional status of the participants before and after 10 weeks of adaptive badminton training sessions are presented in Table 1. Based on the data analysis, a significant improvement in the overall indicator of the physical component of health was observed ($p \leq 0.01$). At the initial stage, this indicator was 59.14 ± 1.49 points, and at the final stage, it was 65.06 ± 0.97 points. The effectiveness of physical functioning in participants in rehabilitation activities also improved significantly ($p \leq 0.01$). The survey showed that, on the eve of the adaptive badminton training course, this indicator was 49.42 ± 1.60 points, and after 10 weeks it was 56.35 ± 1.56. The role-physical functioning also improved significantly ($p \leq 0.05$), and at the end of the course, the participants rated it at 58.88 ± 1.38 points. The indicator characterizing bodily pain did not change significantly ($p \geq 0.05$), but improved by 3.92 points. The results of processing the self-assessment of general health responses indicated significant changes ($p \leq 0.05$). In particular, at the initial stage, this indicator was rated 64.81 ± 1.10 points, and at the final stage, 68.85 ± 1.18 points.

Positive dynamics were observed in the indicators of the mental component of health. In particular, the overall indicator improved by 6.18 points during the training sessions, reaching 76.60 ± 0.65 ($p \leq 0.001$). Among the elements of this component, the highest level of dynamism was observed in the data on the state of well-being and the assessment of a person's vitality (7.07 points). Slightly lower, but reliable, results were observed for indicators of social functioning ($p \leq 0.01$). At the initial stage, 74.12 ± 1.81 points were recorded,

Table 1. Dynamics of indicators of functional status, quality of life, and health of persons with amputations (n = 26), points

Indicators	Stages of research	X ± m	t	p
The Physical Health Component				
Physical Functioning – PF	initial	49.42±1.60	3.10	p≤0.01
	final	56.35±1.56		
Role-Physical Functioning – RP	initial	53.11±1.60	2.73	p≤0.05
	final	58.88±1.38		
Bodily Pain – BP	initial	69.23±2.97	1.06	p≥0.05
	final	73.15±2.20		
General Health – GH	initial	64.81±1.10	2.50	p≤0.05
	final	68.85±1.18		
Overall indicator of the physical health component	initial	59.14±1.49	3.33	p≤0.01
	final	65.06±0.97		
The Mental Health Component				
Vitality – VT	initial	65.28±1.29	4.40	**p≤0.001**
	final	72.35±0.96		
Social Functioning – SF	initial	74.12±1.81	3.46	**p≤0.01**
	final	81.73±1.25		
Role-Emotional Functioning – RE	initial	71.69±1.61	2.47	**p≤0.05**
	final	76.80±1.27		
Mental Health – MH	initial	70.58±1.30	3.24	**p≤0.01**
	final	75.38±0.71		
Overall indicator of the mental health component	initial	70.42±0.72	6.32	**p≤0.001**
	final	76.60±0.65		
"WAM" Functional Status				
Well-being	initial	3.88±0.16	3.48	**p≤0.01**
	final	4.62±0.14		
Activity	initial	4.08±0.16	2.16	**p≤0.05**
	final	4.54±0.14		
Mood	initial	3.96±0.17	4.29	**p≤0.001**
	final	5.12±0.21		
"WAM" overall indicator	initial	3.97±0.08	5.55	**p≤0.001**
	final	4.77±0.12		

Note: X – arithmetic mean; m – standard error; t – Student's t-test value; p – p-value
Source: compiled by the authors of this study

and at the final stage, 81.73 ± 1.25. Positive changes were also found in self-assessment of mental health ($p \leq 0.01$). Before the adaptive badminton course, participants rated their mental health at 70.58 ± 1.30 points; after completion, it was 75.38 ± 0.71. Reliable results were obtained for indicators that assess the level of role-emotional functioning ($p \leq 0.05$). At the initial stage, this indicator was 71.69 ± 1.61 points, and at the final stage, it was 76.80 ± 1.27 points.

The study of the results of self-assessment of the functional status of participants using the "WAM" method also gives grounds to note positive dynamics. There is a clear pattern of changes in well-being, activity, and mood during rehabilitation activities. Significant changes were observed in well-being and mood. According to the survey, participants' well-being before the start of training sessions was rated at 3.88 ± 0.16 points, and after completion at 4.62 ± 0.14 points ($p \leq 0.01$). The smallest, but still significant, changes were recorded in activity indicators – 4.08 ± 0.16 and 4.54 ± 0.14 points, respectively ($p \leq 0.05$). A positive trend in mood self-assessment was observed – 3.96 ± 0.17 points at the initial stage and 5.12 ± 0.21 points at the final stage ($p \leq 0.001$). The overall "WAM" indicator improved by 0.8 points and reached 4.77 ± 0.12 points ($p \leq 0.001$). This can be explained by the presence of internal

attitudes toward the rehabilitation process and by recognition of the participant's personal role in it. A significant factor influencing the psycho-emotional state of individuals is the process of adaptation and attitude to changed living conditions as a result of acquired injuries, in particular amputations.

DISCUSSION

The relevance of the research is confirmed by publications by other scientists [18], who argue that the development of adaptive sports is aimed at improving services in the field of physical culture and sports and building barrier-free environments. The use of adaptive sports in rehabilitation systems for people with limb amputations increases functional mobility, psychological stability, and daily activities [19, 20]. Other scientists are convinced that the psychosocial role of adaptive badminton is to develop a sense of bodily control, increase self-esteem, restore social skills, foster teamwork, and motivate individuals to lead an active lifestyle [7, 12].

Experts [9, 13] recommend using special exercises during adaptive badminton training sessions, including: balancing on a prosthesis with a racket; passing the shuttlecock while maintaining position; strengthening core stability; moving in short distances; balancing with eyes closed; moving with changing support; holding the ball on the racket, etc. Other researchers emphasize the need to strictly adhere to the sequence of stages in implementing the rehabilitation program using adaptive badminton, namely: introductory-adaptive, initial, developmental, and game-reinforcement. In view of the above, scientists emphasize the need to adhere to the methodological principles of the adaptive badminton training process, including: safety, consideration of the type of amputation, prosthetics, psychological state, comprehensiveness, and repeatability. The main task is to ensure the formation of functional motor skills and adaptive mechanisms necessary for performing technical elements of the game, as well as to promote social integration and psychological recovery of participants.

Overall, our results confirm improvements in functional status, quality of life, and health among individuals during adaptive badminton training sessions using both methods. Such results may be due to the effects of physical exertion experienced by participants during specific motor actions in this sport. Moderate physical exercise helps reduce cortisol levels and stimulates endorphin production. Team spirit, emotional support, and a positive psychological atmosphere on the court have beneficial effects on participants' psycho-emotional state, improving mood, reducing tension, anxiety, and depression, and helping participants overcome stress more effectively, owing to their complex effects on the hormonal profile and nervous system.

The results obtained confirm the findings of other scientists [21, 22] regarding the positive effects of moderate physical exercise on functional status, quality of life, and health in veterans, combatants, and persons with disabilities. Involving such persons in adaptive badminton training sessions is one of the most essential tools for their rehabilitation and social integration. The results of our research do not contradict the conclusions of other scientists, but rather expand and complement them.

CONCLUSIONS

It has been established that adaptive physical culture and adaptive sports are essential means of physical and sports rehabilitation for people with amputations. A significant improvement in the overall physical health indicator ($p \leq 0.01$) was found. At the initial stage, this indicator was 59.14 ± 1.49 points; at the final stage, it was 65.06 ± 0.97 points. Significant changes were found in the effectiveness of physical functioning ($p \leq 0.01$), role-physical functioning ($p \leq 0.05$), and overall health in participants in rehabilitation activities ($p \leq 0.05$). Positive but not significant changes were found in the bodily pain indicator ($p \geq 0.05$). Positive dynamics were observed in the indicators of the mental component of health. The overall indicator of the mental element improved by 6.18 points during the training sessions, reaching 76.60 ± 0.65 points ($p \leq 0.001$). Among the aspects of this component, the highest dynamics were recorded in the data on the level of life activity. The increase was 7.07 points and reached 72.35 ± 0.96 points at the final stage ($p \leq 0.001$). Slightly lower, but also significant improvements were observed in indicators of social functioning ($p \leq 0.01$), mental health ($p \leq 0.01$), and role-emotional functioning ($p \leq 0.05$).

Positive changes in participants' functional status during rehabilitation were observed ($p \leq 0.001$). An increase in the overall "WAM" indicator to 4.77 ± 0.12 points ($p \leq 0.001$) was noted, as well as improvements in well-being ($p \leq 0.01$), activity ($p \leq 0.05$), and mood ($p \leq 0.001$). The results of the research justify the broader adoption of adaptive badminton training sessions in physical and sports rehabilitation for people with amputations.

PROSPECTS FOR FURTHER RESEARCH

We see prospects for further research into the impact of adaptive swimming training sessions on the functional status, quality of life, and health of combatants with musculoskeletal injuries.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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