HEALTHY LIFESTYLE. PREVENTION

DOI 10.25789/YMJ.2025.92.15
УДК 796.015.132/369.254.44/356.169

V.D. Kuznetsov, V.S. Cherny, V.V. Arzhakov, A.I. Kravtsov, E.D. Kuznetsova

CONTINUOUS LONG-TERM RUNNING AS A MEANS OF PHYSICAL REHABILITATION FOR MILITARY PERSONNEL OF AIRBORNE TROOPS

This article presents the results of a study aimed at developing a training methodology based on steady, continuous long-distance running to restore the physical fitness and performance of wounded Airborne troops. This methodology aims to facilitate their rapid return to the combat zone and to scientifically substantiate its effectiveness. A three-week training program was developed, including warm-up, base, and warm-up microcycles aimed at gradually increasing the volume and intensity of running loads, developing overall endurance, speed, and sensory abilities. A distinctive feature of the program is the individualization of the training process based on monitoring heart rate variability. The effectiveness of the developed program was experimentally proven, as evidenced by statistically significant improvements in the morphofunctional indicators of physical performance and physical fitness of the experimental group.

Analysis of heart rate variability dynamics demonstrated the program's ability to ensure an optimal level of adaptive capacity and prevent the development of regulatory system overstrain. The results obtained can be used to improve the system of physical rehabilitation of military personnel and increase the combat readiness of Airborne Forces units.

Keywords: physical development, functional state, physical rehabilitation of military personnel, physical training, airborne troops, special military operation.

For citation: Kuznetsov V.D., Cherny V.S., Arzhakov V.V., Kravtsov A.I., Kuznetsova E.D. Continuous long-term running as a means of physical rehabilitation for military personnel of the airborne troops. Yakut Medical Journal. 2025; 92(4): 68-71. https://doi.org/10.25789/YMJ.2025.92.15

Introduction. Physical fitness is a key element of military combat readiness, especially for elite Airborne Forces units operating in extreme conditions. Analysis of combat injuries shows that the extremities are the most vulnerable, accounting for 46% to 75% of all injuries. A significant proportion of these injuries (42.5–54.3%) are of a combined nature, and 9.5–14.4% result in limb avulsion or destruction. The main causes of such injuries are injuries from small arms, artillery munitions, and unmanned aerial vehicles (UAVs). [14,15].

The urgency of the problem of rehabilitation for airborne troops after injuries is driven by several factors. First, the high intensity of modern military conflicts and the use of various types of weapons result in a significant number of wounded, requiring effective rehabilitation methods to ensure their rapid return to duty. Second, the consequences of injuries can significantly reduce physical performance and the body's functional capabilities, limiting the combat effectiveness of military personnel.

Physical inactivity during the recovery period of military personnel after injuries is a significant risk factor for the development of obesity, which critically impedes the restoration of combat readiness and a prompt return to duty. Excess body weight reduces key physical performance indicators (endurance, mobility) and increases the risk of comorbidities, making the development of effective physical rehabilitation methods extremely urgent. In this context, steady, continuous long-distance running is considered a key tool, as it specifically promotes metabolic activation, improves cardiorespiratory function, and reduces weight, directly addressing the problem of obesity prevention and accelerating the readiness of military personnel for combat missions [1, 3, 6, 10].

An important aspect of using running exercises during the rehabilitation of military personnel after injuries is the individualization of the training process taking into account the body's functional capabilities and current health status. In this regard, the use of heart rate variability (HRV) analysis appears promising, allowing one to assess the body's adaptive reserves and select optimal physical exercise regimens [2].

The aim of the study is to develop a training method based on uniform continuous long-term running and to experimentally prove its effectiveness in restoring the physical fitness and performance of wounded military personnel and their rapid return to the combat zone.

Objectives:

1. To develop and scientifically validate a training program for the physical rehabilitation of military personnel, to ensure their rapid return to combat zones;

2. To experimentally demonstrate the effectiveness of the developed training program for the rehabilitation of military personnel returning from hospitals.

Study materials and methods. The study involved military personnel who had returned to their home base after receiving treatment for their wounds. The average age of the participants was 31.2±4.3 years, body length 173.8±6.4 cm, and body weight 89.1±6.1 kg.

The study consisted of three stages (Figure 1). The first stage (organizational) involved selecting candidates and assigning them to the control (CG) and experimental (EG) groups by randomization, assessing their initial functional status, performance, and physical fitness,

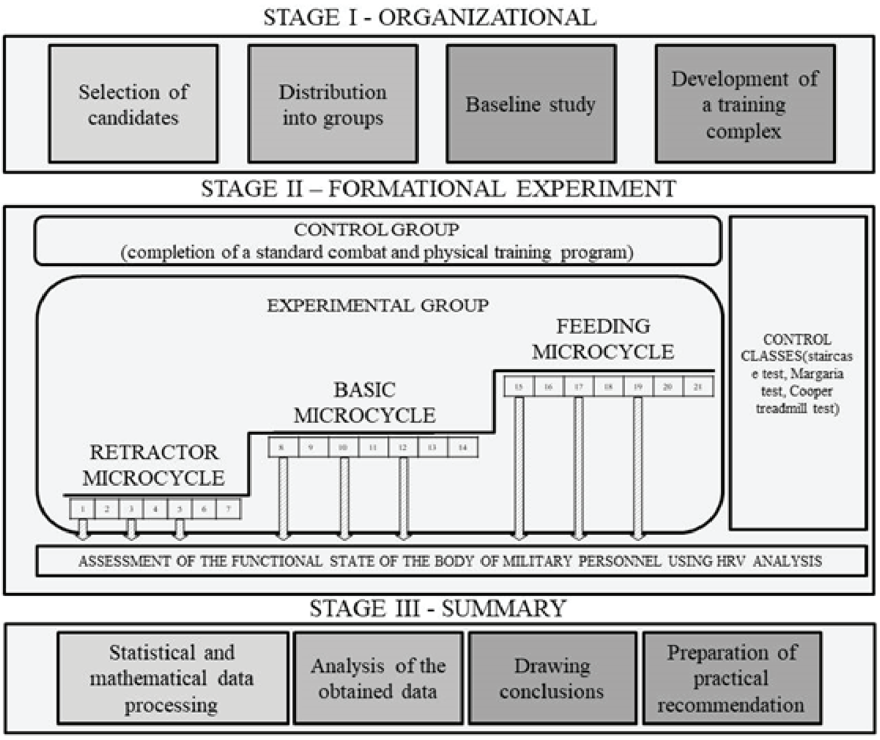
KUZNETSOV Vadim Dmitrievich – PhD, Assistant to the Regiment Commander for Physical Training – head of Physical Training of Military Unit 32515, Airborne Forces, Cherekha village, Pskov Region, ORCID: https://orcid.org/0009-0001-1719-9672, KuznetsovVDedu@yandex.ru; Military Institute of Physical Culture: **CHERNY Valery Stanislavovich** – MD, PhD, Associate Professor, head of the Department; **ARZHAKOV Viktor Viktorovich** – PhD in Pedagogical Sciences, Associate Professor, Professor; **KRAVTSOV Aleksandr Ilyich** – PhD in PedagogicalSciences, Associate Professor; **KUZNETSOVA Ekaterina Dmitrievna** – student of the Smolensk State Medical University, Ministry of Health of the Russian Federation

and developing a training program based on the data obtained. The second stage (formative experiment) consisted of conducting training sessions with military personnel according to the developed program and adjusting training plans based on heart rate variability indicators and conducting tests to assess functional status, physical performance, and physical fitness after completing the training programs. The third stage – summarizing the results – included mathematical and statistical processing of the obtained data, discussion of the study results, drawing conclusions, and developing practical recommendations.

Heart rate variability analysis was used to assess functional status. The analysis was conducted within an hour of arriving for duty in the morning. Before the examination, service members remained motionless in a dark room for 15 minutes. The results were recorded in an individual protocol. Cardiac rhythmograms were recorded for 300 cardiac cycles in clinostasis. Spectral HRV parameters were assessed, frequency power parameters were calculated in the high-frequency (HF, ms²), low-frequency (LF, ms²), and very-low-frequency (VLF, ms²) ranges, total spectral power (TP, ms²), temporal parameters (SDNN, ms² and rMSSD, ms²), and the stress index (SI, c.u.) and regulatory system activity indicators (PARS, score) were also assessed.

To assess the level of physical performance of military personnel, the “Staircase Test” test was used, and their physical fitness was determined using the Margaria test, the Cooper running test, and the «Complex agility exercise» test – Exercise No. 30 from the NFP-2023.[11] The choice of these tests was due to the need to ensure a moderate load and the possibility of prompt medical support.

We used various statistical methods to analyze the obtained results. The Kolmogorov-Smirnov test was used to check the normality of the distribution of quantitative variables. One-way analysis of variance was used to compare the results of multi-day measurements. Comparisons of quantitative variables within and between groups were performed using the Student's t-test for dependent and independent samples (M ± m). When comparing qualitative variables, we additionally used the Pearson chi-square test with significance adjustment (for between-group differences) and the McNemar test (for within-group changes) (Md [Q1;Q3]). Differences were considered statistically significant at $p < 0.05$. Mathematical and statistical data processing



Study design

was performed using STATISTICA 10 software.

Key provisions. Rehabilitation of military personnel in medical and health resort facilities (HRFs) is primarily focused on the following objectives: accelerating the resolution of edema and hematomas; preventing the development of contractures; restoring the functionality of the damaged organ; stimulating blood and lymph circulation; developing compensatory mechanisms for the loss of basic motor functions; improvement of the general condition of the patient [3, 6].

The existing approach to the rehabilitation of wounded military personnel, while successfully restoring them to a level of basic working capacity, is insufficient for the full return to duty of airborne assault units. Modern combat demands fundamentally different requirements: the ability not only to march long distances with heavy equipment under enemy fire, but also, crucially, to react instantly and maneuver with high agility to evade UAV attacks. Thus, there is an urgent need to rethink rehabilitation, shifting the emphasis from simple recovery to the targeted development of key physical qualities—endurance, speed, strength, and agility – to ensure not just a return to duty, but true combat readiness [3, 8, 13].

Researchers A. A. Musin and I. V. Polyakova (2024) argue in their work that, in order to rehabilitate and restore the professional readiness of military personnel, it is first and foremost necessary to use game-based physical training, justifying this by the popularity and spectacle of team sports, especially football, which, in addition to the physical development of almost all necessary qualities (speed, endurance, and agility), contribute to stress relief [10].

Unlike the game-based method, which is difficult to individualize and carries the risk of overexertion and injury, steady, continuous running is a more effective and accessible means of physical rehabilitation for wounded soldiers. This type of exercise is easily dosed and adapted to individual plans, allowing for targeted development of overall endurance, speed, and willpower, ensuring a safe and gradual restoration of physical fitness for a return to professional activity. [3, 7, 5, 12].

An integrated approach combining running training, proper nutrition, and flexibility exercises ensures comprehensive recovery for military personnel. Running effectively normalizes body weight, develops strength endurance, and, importantly, significantly improves psycho-emotional well-being by reducing stress. Incorporating flexibility exercises into the program directly accelerates physical recovery, reducing muscle tension and the risk of re-injury. Combining these elements allows for faster and more complete physical and psychological rehabilitation, facilitating the rapid re-

Average indicators of physical development, performance and physical fitness of military personnel in the experimental and control groups before and after the experiment

Indicators		Before			After			p	
		CG	EG	p	CG	EG	p	CG	EG
Body weight, kg		89.9±1.1	88.4±1.1	0.15	85.8±1.1	75.5±1.1	0.05	0.05	0.01
BMI, kg/m^2		29.4±0.4	29.7±0.6	0.3	28.1±0.4	25.4±0.5	0.05	0.1	0.05
Staircase test, bpm		139.8±1.8	140±1.7	0.8	125.6±1.7	114.5±1.9	0.05	0.05	0.01
Margaria test	Watts	401.6±9.4	390.5±9.2	0.25	424±9.8	557.8±15	0.05	0.25	0.001
	Watts/kg	4.5±0.1	4.4±0.1	0.5	4.9±0.1	7.4±0.2	0.05	0.25	0.05
Exercise №30, sec		13.7±0.4	14.3±0.3	0.05	13.4±0.3	13.1±0.3	0.1	0.1	0.05
Cooper test, m		2167.2±31.6	2164.3±29.2	0.25	2381.8±37.4	2665.2±38.9	0.05	0.05	0.05

turn of military personnel to full duty. [5, 6, 7, 9]

Based on the above-mentioned characteristics, our working group developed a training plan for the physical rehabilitation of military personnel in a military unit setting. This plan consists of a three-week mesocycle aimed at improving marching composure, developing general endurance, speed, and sensory abilities, as well as weight management through a gradual increase in running volume.

The first, induction microcycle (Figure 2) serves as a fundamental stage for the smooth and safe adaptation of military personnel to the demands of continuous long-distance running. Its program, designed for five training sessions, is built on the principle of gradual progression: initially, walking predominates, but with each session, the emphasis gradually shifts toward increasing the proportion of running. Each session begins with a preparatory exercise program aimed at activating muscles and preparing the body, and concludes with restorative exercises to relieve tension and accelerate recovery. A key control and safety tool is strict heart rate monitoring (conducted using personal fitness trackers and heart rate monitors (Garmin, Polar, Suunto)), the threshold of which is set at no higher than (130) 150 bpm, with planned rest breaks if this threshold is exceeded. This carefully considered approach allows for careful adaptation of the cardiovascular and respiratory systems, minimizing the risk of injury and building a solid foundation of physical fitness necessary for a successful transition to more intense exercise during the subsequent micro-cycle of rehabilitation.

The basic microcycle (Figure 2), which comprises the second week of rehabilitation, aims to gradually increase running volume to 175 minutes over five training sessions. Its key feature is the introduction of a post-run routine, alternating specific running exercises (4-6) to improve running technique and strength exercises (3-4) for the muscles of the arms, shoulder girdle, torso, and legs to reduce injury. The training process takes place in the first developmental mode at a heart rate of 130-150 bpm, ensuring optimal training effects with minimal risk of overtraining. This microcycle structure promotes the effective development of overall endurance and running fitness, creating conditions for the body's safe adaptation to increasing workloads.

The preparatory microcycle, implemented in the third week (Figure 2), aims to integrate speed training by introducing accelerations (30–50 m) into the structure of five training sessions. During the training, basic running in the first developmental mode (heart rate 130–150 bpm) is interrupted by a progressively increasing number of accelerations (from 6 to 10 per session), during which the intensity reaches the third developmental mode (heart rate from 170 bpm). This structure simulates the «jerky» nature of running typical of combat conditions and promotes the body's comprehensive adaptation to high-intensity loads. As a result, this final stage of the mesocycle ensures the development of not only general endurance but also the specific speed qualities, attention, and sensory abilities of the service member.

At the end of three weeks, the study was repeated with the servicemen of the EG and CG groups (Table 1).

The servicemen in the experimental group showed statistically significant and more pronounced positive changes compared to the control group. In particular, the experimental group showed a significant decrease in body weight (by 12.9 kg; $p<0.01$) and a significant improvement in physical performance according to the "Staircase test" (a decrease in heart rate by 25.5 bpm; $p<0.01$). A highly significant ($p<0.001$) increase in absolute and relative power according to the Margaria test and an improvement in agility indicators in exercise #30 ($p<0.05$) were also revealed, while in the control group similar dynamics were statistically less significant. In addition, the increase in overall endurance according to the Cooper test in the experimental group (500.9 m) was more than twice as high as the results in the control group (214.6 m).

An analysis of HRV dynamics confirmed the high adaptability of the experimental program. The servicemen in the control group, who initially had normal parameters, demonstrated an adequate response to the load: by the end of each week, a temporary, statistically significant ($p<0.05$) increase in regulatory systems was recorded (e.g., a 20.5% increase in SI), which was fully compensated for after two days of rest, which also allowed for individual adjustments to the program. A key result was the state after the control tests: unlike the control group, which demonstrated pronounced signs of overexertion (a 25.6% decrease in SDNN, a 30.7% decrease in rMSSD; $p<0.01$), the servicemen in the control group maintained HRV parameters within physiological norms. This demonstrates the effectiveness of the developed method in increasing the body's adaptive potential and preventing adaptation failure.

Conclusion. The study experimentally validated the high effectiveness of the developed three-week physical rehabilitation method for military personnel after injuries, based on steady-state running with individualized loads based on HRV parameters.

The developed program, including warm-up, base, and warm-up microcycles, provided statistically significant improvements in physical performance, overall endurance, power, and agility in the experimental group, while reducing body weight. HRV monitoring confirmed that the program maintains an optimal level of adaptation, preventing overstrain of regulatory systems, making it a reliable and effective tool for comprehensive recovery and accelerated preparation of military personnel for return to combat zones.

The authors declare no conflict of interest.

References

1. Razumov A.N., Dolgikh S.V., Kirsanova A.A., et al. Aktual'nye voprosy medicinskoj i mediko-psihologicheskoj reabilitacii voennosluzhashchih voenno-morskogo flota [Current issues in medical and medical-psychological rehabilitation of naval servicemen]. Kurortnaia meditsina [Spa medicine. 2023; 3: 32–40 (In Russ.).] DOI 10.51871/2304-0343_2023_3_32. EDN ZGQIEU.

2. Arzhakov V.V., Kuznetsov V.D., Gritsenko A.Ya. Ocenka sorevnovatel'noj vynoslivosti voennosluzhashchih vozdushno-desantnyh vojsk, uchastvuyushchih vo Vsearmejskom konkurse «Desantnyj vzvod» po dannym analiza variabel'nosti serdechnogo ritma [Evaluation of competitive endurance of airborne troops personnel participating in the All-Army competition \"Airborne Platoon\" based on heart rate variability analysis. Yakut medical journal. 2024; 1(85): 116–120 (In Russ.).] DOI 10.25789/YMJ.2024.85.29. EDN FFPPXC.

3. Bagretsova N.S. Reabilitaciya voennosluzhashchih, poluchivshih razlichnye raneniya v hode special'noj voennoj operacii, v vide fizicheskih uprazhnenij [Rehabilitation of military personnel who received various injuries during a special military operation, in the form of physical exercises]. Sovremennye trendy razvitiya regionov: upravlenie, pravo, ekonomika, socium: Materialy XXII Vserossijskoj studencheskoj nauchno-prakticheskoj konferencii [Modern trends in regional development: management, law, economics, society: Proceedings of the XXII All-Russian Student Scientific and Practical Conference, Chelyabinsk, April 24–25, 2024. Chelyabinsk: Federal State Budgetary Educational Institution of Higher Education “Russian Presidential Academy of National Economy and Public Administration”, 2024. P. 390–392. EDN KNJNIF (In Russ.).]

4. Esipov A.V., Sukhorukov A.L., Musailov V.A., et al. Velichina i struktura izolirovannyh ranenij konechnostej v sovremennyh lokal'nyh konfliktah (obzor literatury) [The Magnitude and Structure of Isolated Limb Wounds in Modern Local Conflicts (Literature Review)]. Voenno-medicinskij zhurnal [Military Medical Journal. 2023; 3: 33–39 (Russ.).]

5. Gareev D.R., Saparov B.M., Lyanka S.E. Polozhitel'noe vliyanie zanyatij begom na organism [The Positive Effects of Running on the Body]. Molodezh' i nauka [Youth and Science. 2022; 9: 23–34. EDN VOFCLP (In Russ.).]

6. Demyanov V.A., Kurshakov M.V., Seregin A.A. Primenenie fizicheskih uprazhnenij dlya reabilitacii voennosluzhashchih posle travm i ranenij [Application of physical exercises for rehabilitation of military personnel after injuries and wounds]. Aktual'nye problemy sovremennoj sistemy fizicheskoj podgotovki v vuzah Ministerstva oborony Rossijskoj Federacii : sb. nauch. statej Mezhvuzovskoj nauchno-prakticheskoj konferencii [Actual problems of the modern system of physical training in universities of the Ministry of Defense of the Russian Federation: collection of scientific articles of the Interuniversity scientific and practical conference: in 2 parts, St. Petersburg, November 23, 2022. Volume Part 1. St. Petersburg: Military Institute of Physical Culture. 2022. P. 104-110. EDN ZBCLKB (In Russ.).]

7. Korobeinikova E.I., Kondrashov A.G. Beg kak garant zdorovogo obraza zhizni [Running as a guarantor of a healthy lifestyle]. Avtonomiya lichnosti [Personal autonomy. 2021; 2 (25): 142-148. EDN TRWNWX (In Russ.).]

8. Kuznetsov V.D. Osobennosti voenno-professional'noj deyatel'nosti voennosluzhashchih - operatorov FPV-dronov podrazdelenij VDV v usloviyah boevyh dejstvij [Features of the military-professional activities of servicemen - operators of FPV drones of airborne forces units in combat conditions]. Chelovecheskij capital [Human capital. 2024; 12 (192): 220-229 (In Russ.).] DOI 10.25629/HC.2024.12.22. EDN HKYSKY.

9. Kuznetsov V.D., Kuznetsova M.A., Kuznetsov R.P. Primenenie uprazhnenij dlya razvitiya gibkosti s cel'yu korrektirovki funkcional'nogo sostoyaniya voennosluzhashchih, vystupayushchih v rukopashnoj skhvatke v konkurse voenno-polevoj vyuchki «Desantnyj vzvod» [The Use of Flexibility Exercises to Improve the Functional State of Military Personnel Competing in Hand-to-Hand Combat in the Airborne Platoon Military Field Training Competition]. Integraciya nauki i sportivnoj praktiki v edinoborstvah: Materialy XXIII mezhdunar. nauchno-praktich. konf. molodyh uchenyh, posv. pamyati zasluzhennogo mastera sporta SSSR, zasl. trenera SSSR, prof. E.M. Chumakova [Integration of Science and Sports Practice in Martial Arts: Proceedings of the XXIII International Scientific and Practical Conference of Young Scientists Dedicated to the Memory of Honored Master of Sports of the USSR, Honored Coach of the USSR, Professor Evgeny Mikhailovich Chumakov, Moscow, February 16, 2024. Moscow: Russian University of Sports \"GTsOLIFK\", 2024. P. 98-102. EDN FAOGJM (In Russ.).]

10. Musin A.A., Polyakova I.V. Teoreticheskoe obosnovanie primeneniya elementov futbola v dvigatel'noj reabilitacii voennosluzhashchih [Theoretical justification for the use of football elements in the motor rehabilitation of military personnel]. Adaptivnaya fizicheskaya kul'tura i sport: problemy, innovacii, perspektivy : Materialy III Vserossijskoj nauchno-prakticheskoj konferencii s mezhdunarodnym uchastiem [Adaptive physical education and sport: problems, innovations, prospects: Proceedings of the III All-Russian scientific and practical conference with international participation, Tula, October 25, 2024. Tula: Tula L.N. Tolstoy State Pedagogical University, 2024. Pp. 162-165. EDN GMKJIU (In Russ.).]

11. Nastavlenie po fizicheskoj podgotovke v Vooruzhennyh Silah Rossijskoj Federacii: prikaz Ministra oborony Rossijskoj Federacii № 230 ot 20 aprelya 2023 goda [Instructions on physical training in the Armed Forces of the Russian Federation: order of the Minister of Defense of the Russian Federation No. 230 of April 20, 2023. 143 p. (In Russ.).]

12. Savova E.M., Zavarina A.Yu., Shvedunova V.N., et al. Ocenka effektivnosti i bezopasnosti aerobnyh ciklicheskih trenirovok u detej posle hirurgicheskoj korrekcii vrozhdennyh porokov serdca i osobennosti kratkovremennoj adaptacii v zavisimosti ot vida patologii [Evaluation of the Efficiency and Safety of Aerobic Cyclic Training in Children After Surgical Correction of Congenital Heart Defects and Features of Short-Term Adaptation Depending on the Type of Pathology]. Voprosy kurortologii, fizioterapii i lechebnoj fizicheskoj kul'tury [Issues of Balneology, Physiotherapy, and Therapeutic Physical Culture. 2025; 102 (1): 19-31.

13. Rodionov I.S., Kuznetsov V.D., Arzhakov V.V. Znachenie fizicheskoj podgotovlennosti operatorov udarnyh FPV-dronov VDV na raznyh etapah voenno-professional'noj deyatel'nosti v usloviyah boevyh dejstvij [The Importance of Physical Fitness of Airborne Forces FPV Drone Operators at Different Stages of Their Military Professional Activities in Combat Conditions]. Uchenye zapiski universiteta imeni P.F. Lesgafta [Scientific Notes of P. F. Lesgaft University. 2025; 3 (241): 48-54 (In Russ.).] DOI 10.5930/1994-4683-2025-48-54. EDN KXGXPY.

14. Trishkin D.V., Sergoventsev A.A., Yudin V.E., et al. Sovremennaya sistema reabilitacii i abilitacii voennosluzhashchih s amputaciej konechnostej [Modern system of rehabilitation and habilitation of military personnel with limb amputations]. Voenno-medicinskij zhurnal [Military Medical Journal. 2023; 2: 4–13 (In Russ.).]

15. Kasimov R.R., Khezhev M.A., Samokhvalov I.M., et al. Struktura boevoj hirurgicheskoj travmy i osobennosti okazaniya hirurgicheskoj pomoshchi v peredovyh medicinskih gruppah v neaktivnuyu fazu boevyh dejstvij [The structure of combat surgical trauma and the specifics of providing surgical care in forward medical groups during the inactive phase of combat operations]. Voenno-medicinskij zhurnal [Military Medical Journal. 2025; 346 (3): 4–13 (In Russ.).] DOI 10.52424/00269050_2024_346_3_4. EDN IMUTTQ.