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CONTENT

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Functional overreaching and adaptation failure in special operations forces servicemen with varied resistance during intensive loads

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Abstract

Purpose. To study the features of manifestations of adaptive and compensatory reactions for assessing the state of functional overreaching against the background of adaptation failure of special operations forces servicemen with different levels of resistance in the process of intensive loads.

Material & Methods. 75 special operations forces servicemen (men) aged 25±3.2 years were examined. Previously, the participants were using high-intensity loads with a large volume of work in their units for 3 months. The participants were divided into three groups depending on their units. During the test trials, modes of strength loads of different volumes and intensities were used (R_a=0.56; R_a=0.68; R_a=0.78). To assess the basal level and features of adaptive and compensatory reactions of the examined in response to a stress stimulus, indicators of spectral analysis of heart rhythm and blood biomarkers (creatine phosphokinase, lactate dehydrogenase, cortisol) were used.

Results. It was established that after the preliminary 3 months of high-intensity training, 50% of servicemen of each unit have a high level of adaptive reserves. Thus, these participants (subgroups 1^A, 2^A, 3^A), by the type of heart rhythm regulation, belong to normotensives, and the studied blood biomarkers are within the reference values. In the other part of the examined, the initial parameters of the tension of the heart rhythm regulation systems were on average 5.4 times higher compared to the opponents, and the basal level of biochemical blood indicators exceeded the upper limits of the reference. Similar results of the studied biomarkers, which were found in the servicemen of the subgroups (1^B, 2^B, 3^B), indicate a possible state of adaptation failure. It was found that in response to test trials using different load modes, in servicemen of each of the subgroups with adaptation failure, a completely opposite nature of adaptive and compensatory reactions was recorded. A decrease in the level of tension of the heart rhythm regulation systems and VLF power, stability of the cortisol level in the blood, and the absence of enzymes exceeding the reference limit in response to a stimulus indicate the mechanisms of short-term adaptation. The effectiveness of the implementation of short-term adaptation mechanisms was recorded only in servicemen of subgroup 2^B (R_a=0.68) and in representatives of subgroup 1^B (R_a=0.78). In all other cases, a shift in the autonomic balance towards sympathetic activity was recorded against the background of strengthening

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the central circuit with a simultaneous increase in lactate dehydrogenase and a decrease in cortisol in the blood, which indicates compensatory reactions to the stimulus.

Conclusions. It was established that in servicemen, regardless of the peculiarities of their special operations forces units, training system, and even the type of heart rhythm regulation, we simultaneously record both a high level of functional capabilities and a state of adaptation failure. It was investigated that the use of basal parameters of HRV indicators and biochemical blood indicators to determine the state of functional overreaching (FOR) in servicemen of special operations forces units with signs of adaptation failure is insufficient. The identified features of adaptive and compensatory reactions of the body of special operations forces servicemen against the background of adaptation failure to different intensity load modes require a radical correction of the process of optimizing the training system.

Keywords: servicemen, functional overreaching, adaptation failure, biomarkers, load modes, resistance level, adaptive and compensatory reactions.

Introduction

The constant increase in the intensity and volume of training loads in the process of physical training of special operations forces servicemen is one of the main causes of overloads with the subsequent development of a state of adaptation failure [1, 2]. The complication of this problem is justified by the absence of a clear mechanism not only for optimizing training loads taking into account the individual level of resistance and adaptive reserves, but also for developing an effective mechanism for their correction [3, 4]. The constant activation of compensatory mechanisms against the background of high-intensity loads close to maximum leads to the development of a state of functional overreaching (FOR) due to the lack of an effective process of full recovery of the body's energy reserves [5, 6]. Insufficient attention paid to the development of an integrated system for monitoring the nature of adaptive and compensatory reactions under conditions of different loads during a long-term training period is a key problem in the manifestations of non-functional overreaching (FOR) and even the development of overtraining syndrome (OTS) [7]. The difficulty of counteracting the emergence of such problems is associated with the lack of the possibility of using a wide range of physiological and biochemical methods of diagnosing the state of special operations forces servicemen in the process of operational control.

In the modern system of functional training of servicemen of this direction, there is no scientifically substantiated concept regarding the development of the most effective strength load modes taking into account the characteristics of each special forces unit [8]. The difficulty of implementing this problem is due to the fact that during the performance of most training loads, servicemen mainly use exercises with their own body weight. At the same time, in most cases, taking into account the peculiarities of the structure and content of training programs in these units, the load parameters used will contribute mainly to the development of strength endurance [9]. Accordingly, the resistance level of their body systems will increase only to a certain range of loads, which in terms of volume and intensity are used in most training sessions [10]. At the same time, a change in the conditions of intense muscle activity, due to the influence of unpredictable factors, will lead to the need to activate compensatory mechanisms to ensure effective task performance [11]. Under conditions of prolonged use of loads to which servicemen have a low resistance level, the risk of adaptation failure, the development of adaptation failure states, and functional overreaching significantly increases [12, 13].

Purpose of the Study. To study the features of manifestations of adaptive and compensatory reactions for assessing the state of functional overreaching against the background of adaptation failure of special operations forces servicemen with different levels of resistance in the process of intensive loads.

Material and Methods

Participants

The research involved 75 servicemen (men) of special operations forces units. The age of the examined was 25±3.2 years. Depending on the characteristics of the units, the participants were divided into 3 groups (25 people in each). The first group included servicemen who are representatives of special and intelligence units of the Defence Intelligence of Ukraine of the Ministry of Defence of Ukraine. The second group consisted of servicemen of special units of the Special Operations Forces of the Armed Forces of Ukraine. The basis of the third group was servicemen of special units of the State Border Guard Service of Ukraine. According to the results of the military medical commission, the participants of all three

groups had no contraindications for conducting such studies. The research was conducted on the basis of departments of the Scientific Research Center of Modern Kinesiology "KINEZUS" in Kyiv, Dnipro, Chernivtsi, and Mykolaiv during 2025. The research design was approved by the Bioethics Committee of Lesya Ukrainka Volyn National University (ECBR 21.01.2025). After explaining the risks and benefits of the study, the participants signed an informed consent form prepared in accordance with the ethical standards of the Declaration of Helsinki.

Measurements

Heart rate variability (HRV).

To determine the initial parameters of heart rate variability (HRV) indicators and the features of their changes, the Polar V800 heart rate monitor was used. According to the instructions [14], the Polar V800 heart rate monitor was primarily used to measure RR intervals. To register HR indicators and raw RR intervals, a special sensor (Polar) installed on the chest strap (H10) was used. The obtained data were uploaded from the Polar V800 to the Polar Flow web service, and then the processed results were downloaded to a laptop. Using the Kubios HRV Standard 3.5.0 software, calculations of the obtained HRV parameters were carried out in the time (statistical) and frequency (spectral) domains. During the analysis of spectral characteristics of HRV, the following indicators were evaluated: VLF (very low-frequency spectrum of cardio intervals), LF (sympathetic activity), HF (parasympathetic tone), and LF/HF (balance of vagal-sympathetic tone mechanisms). The registration of RR interval signals in the examined was carried out in a sitting position at rest before and after each test trial. The rest interval between test trials was 35-40 minutes, during which the examined lay in a calm state with their eyes closed in a quiet room at a temperature of about 22°C. The optimal duration of recording RR intervals, according to research standards of HRV, was 5 minutes.

Blood Biomarkers

The activity of enzymes lactate dehydrogenase (LDH) and creatine phosphokinase (CPK) in the blood serum of servicemen was determined by the kinetic method on the equipment of High Technology Inc (USA) with a set of reagents PRESTIGE 24i LQ LDH (Poland). The concentration of cortisol in the blood serum of the examined was determined by the method of enzyme-linked immunosorbent assay, using a set of reagents SteroidI-FA on the equipment of the company Alkor Bio. The reference values of the studied biochemical indicators in the blood serum of the participants: CPK (40-270 U/L), LDH (195-462 U/L), and cortisol (150-660 nmol/L). Blood sampling was carried out by medical workers in accordance with internationally accepted requirements for biomedical research. During the control process, the basal level (at rest before loads) of the studied blood biomarkers in the examined servicemen and the features of their changes in response to the proposed test loads were assessed.

Quantitative assessment of load mode

To determine the load mode, control sections and calculations of the following quantitative indicators were carried out: duration of one repetition (t), number of repetitions in a separate set (n), maximum load mass (m_{max}), working load mass (m), conditional amplitude coefficient (Q), f_o – empirical coefficient [15]. The load coefficient (load mode) was determined by the formula:). The indicator of working load mass (m) was determined by the formula . m is the weight of blocks on the simulator that a serviceman can overcome until complete muscle fatigue in a given load mode. m_{max} is the maximum weight of the load (kg), which a participant can overcome when performing control physical exercises only once.

Test loads

Test trials were proposed using three models of load modes, with the most common in power sports variation of combining the main structural components. Such load modes are used in the process of long-term training activities for the functional reserves of the body. During the test trials, a classic combination was applied with the use of a set of exercises of bench press and behind-the-neck pulldown in the Hammer simulators. Free weight exercises (bar, dumbbells) and classic bodyweight exercises (crossbar, parallel bars) were not used to reduce the risk of injury. 4 sets were used for each exercise with a rest interval between them of 50-60 s. Depending on the characteristics of the specified load modes, the appropriate set of indicators of the working load mass in combination with the number of repetitions in a separate set was used.

Research Design

The research was conducted in several stages during 2025.

At the first stage, a mechanism was developed to assess the state of functional overreaching in special operations forces servicemen against the background of adaptation failure after prolonged loads approaching the maximum in terms of volume and intensity. The functional state of servicemen of the examined groups was assessed after the completion of the previous stage of high-intensity physical training in their units with a large volume of work, which lasted for 3 months.

At the second stage, based on the analysis of the assessment results of the initial level of the

functional state of the examined, each group of servicemen was divided into subgroups. Subgroup A included servicemen who, by the type of heart rhythm regulation, belonged to normotensives (the LF/HF indicator ranges from 0 to 2.5). At the same time, in representatives of subgroups A, the studied blood biomarkers (CPK, LDH, cortisol) do not go beyond the reference values. Representatives of subgroups B were servicemen who, by the type of heart rhythm regulation, belonged to sympathicotonics (LF/HF>2.5). In participants of subgroups B, the controlled basal parameters of biochemical blood indicators exceeded the upper limits of the reference (H (High)↑). Taking into account the peculiarities of the obtained results and the purpose of this work, representatives of subgroups B will participate in further studies.

At the third stage, the peculiarities of changes in the spectral analysis of HRV and the studied blood biomarkers of servicemen of subgroups B (1^B, 2^B, 3^B) in response to a given stress stimulus were studied. During test trials, strength load modes of different volume and intensity were used (R_a=0.56; R_a=0.68; R_a=0.78). The obtained results were processed. A comparative analysis was carried out on the features of the adaptive and compensatory body reactions of servicemen of these subgroups of different units in response to a given physical stimulus.

Statistical Analysis

Using the IBM *SPSS*Statistics 26 software package, a statistical analysis of the research results was performed. The G-Power 3.1.96 program (Germany) allows determining the minimum sample size for the research (calculation of statistical power). Using non-parametric methods of statistical analysis, the median (Me) and interquartile range (IQR) were determined. The Kruskal-Wallis test was used to compare the initial parameters between the three groups of examined servicemen of special operations forces units. The Wilcoxon signed-rank test was used to compare two dependent samples with each other.

Results

Fig. 1 presents a mechanism for assessing the state of functional overreaching in special operations forces servicemen against the background of adaptation failure after prolonged loads approaching the maximum in terms of volume and intensity.

This mechanism is based on two key components, one of which is related to a detailed assessment of the previous physical training system. In the process of analysis, the structure and content of training models, as well as the characteristics of load modes, were studied. The second important component is the assessment of the functional state of servicemen of this category after prolonged use of such training loads. The use of an optimal range of physiological and biochemical methods for diagnosing body systems allows, even on the basis of basal parameters of HRV and blood biomarkers, to determine a possible state of adaptation failure, or a high level of adaptive reserves. Determination of the resistance level of servicemen with a probable state of adaptation failure to load modes of different volume and intensity occurs due to control over the nature of adaptive and compensatory reactions to the stimulus. A detailed analysis of the results of changes in HRV indicators and blood biomarkers under conditions of this stress will allow, in one case, to assess the effectiveness of the implementation of short-term adaptation mechanisms of the examined servicemen. In another case, against the background of a pronounced constant activation of compensatory mechanisms in response to loads, a state of functional overreaching will be recorded.

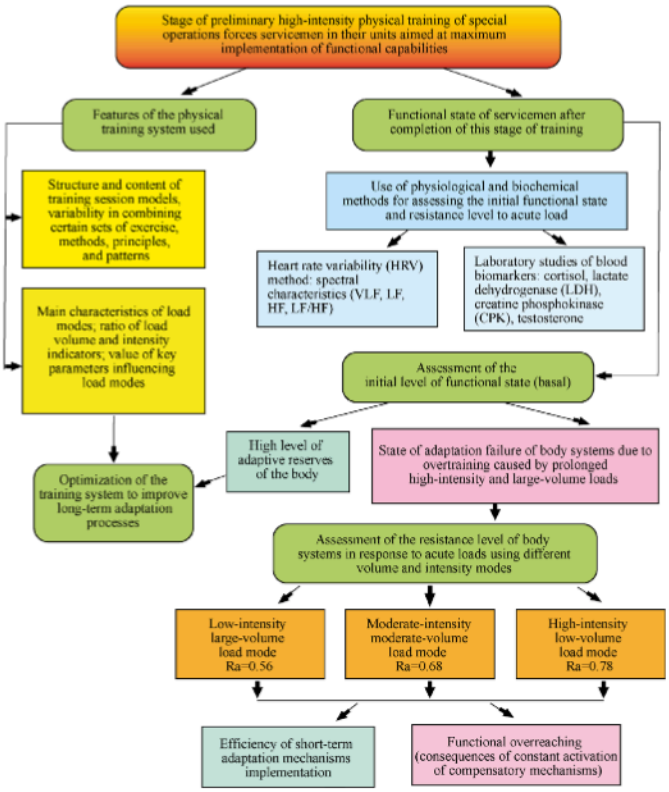

Fig. 1. Mechanism for assessing the state of functional overreaching in special operations forces servicemen against the background of adaptation failure after prolonged loads approaching the maximum in terms of volume and intensity

Table 1 presents the results of the basal level of spectral analysis indicators of the heart rhythm of the examined groups of special operations forces servicemen recorded after the previous stage of training.

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Table 1. Results of the basal level of spectral analysis indicators of the heart rhythm of the examined groups of special operations forces servicemen recorded after the previous stage of training (Me, IQR), n=75

Groups of servicemen of the examined units		HRV indicators			
		VLF, %	LF, %	HF, %	LF/HF
1	1^A	2.86 (0.18)	55.71 (3.17)	41.38 (2.96)	1.34 (0.10)
	1^B	18.36 (0.99)	70.41 (4.22)	11.19 (0.78)	6.29 (0.51)
2	2^A	3.16 (0.25)	52.58 (3.23)	44.13 (3.01)	1.19 (0.08)
	2^B	48.42 (2.91)	45.69 (3.18)	5.86 (0.42)	7.79 (0.55)
3	3^A	4.48 (0.31)	58.04 (3.28)	37.44 (2.28)	1.55 (0.11)
	3^B	9.47 (0.77)	81.07 (5.19)	9.46 (0.72)	8.56 (0.63)

Notes: subgroups 1^A, 2^A, 3^A – normotensives (basal level of LH/HF = from 0 to 2.5 standard units); subgroups 1^B, 2^B, 3^B – sympathicotonics (basal level of LH/HF>2.5 standard units).

Table 2. Results of the basal level of the studied blood biomarkers in the examined groups of special operations forces servicemen recorded after the previous stage of training (Me, IQR), n=75

Groups of servicemen of the examined units		Blood biomarkers		
		CPK, U/L	LDH, U/L	Cortisol, nmol/L
1	1^A	62.24 (4.83)	223.08 (17.29)	172.73 (12.54)
	1^B	149.73 (10.63)	**478.21** (31.52) **H↑**	**680.16** (42.21) **H↑**
2	2^A	94.08 (6.21)	275.23 (18.05)	229.92 (16.89)
	2^B	**284.33** (19.07) **H↑**	**525.32** (32.71) **H↑**	**722.11** (38.41) **H↑**
3	3^A	103.64 (8.22)	256.45 (18.02)	356.05 (22.14)
	3^B	**292.18** (15.97) **H↑**	**574.65** (32.03) **H↑**	**754.73** (37.91) **H↑**

*Notes: **H (High)** ↑ – exceeding the reference values of the studied blood biomarkers in the examined servicemen.*

It was established that at this stage of the study, almost 50% of servicemen from each of the three special operations forces units have significantly different basal level spectral analysis indicators. Taking into account the results obtained, regardless of the characteristics of the units, the participants of each group were divided into two subgroups (A and B). Thus, by the type of heart rhythm regulation, servicemen of subgroups 1^A, 2^A, 3^A belong to normotensives (LH/HF= from 0 to 2.5). While representatives of subgroups 1^B, 2^B, 3^B belong to sympathicotonics (LH/HF>2.5). It was found that the basal level of tension of the heart rhythm regulation systems in servicemen of subgroups 1^B, 2^B, 3^B is, on average, 5.4 times higher compared to other participants. Representatives of subgroups B recorded 2 times (3^B), and in some cases 15 times (2^B) higher activity of the central circuit of sinus rhythm regulation compared to servicemen of subgroups A.

Table 2 presents the results of the basal level of the studied blood biomarkers in special operations forces servicemen recorded after the previous stage of training.

Analysis of laboratory studies indicates that in servicemen of subgroups 1^A, 2^A, 3^A, who belong to normotensives, the basal level of the studied blood biomarkers (CPK, LDH, and cortisol) is within the reference range. At the same time, in participants who were assigned to subgroups "B" by the type of heart rhythm regulation, the controlled biochemical blood parameters exceeded the upper limits of the reference values. For example, the most pronounced exceeding of the reference limits (CPK +10.4%; LDH +24.8%; cortisol +14.3%) was found in servicemen of subgroup 3^B.

Thus, a detailed analysis of the results presented in Tables 1 and 2 allows us to assume that after the completion of the previous stage of training, a part of the examined servicemen (subgroups 1^A, 2^A, 3^A) has a high level of adaptive reserves. In about 50% of the examined representatives of special operations forces units (subgroups 1^B, 2^B, 3^B), pronounced manifestations of a

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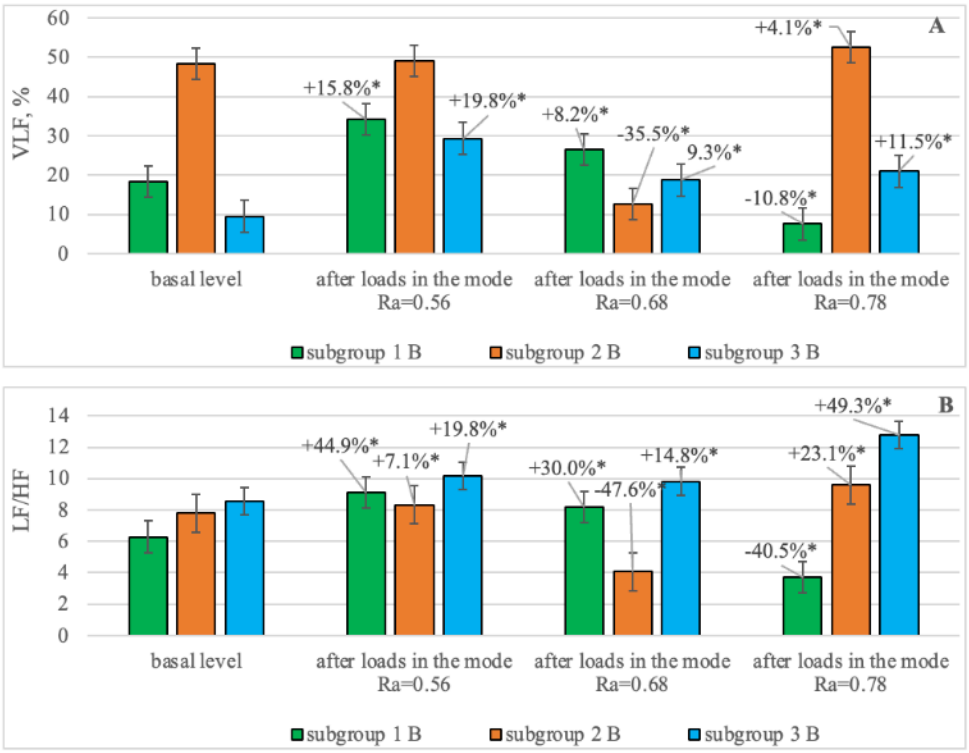

Fig. 2. Results of changes in indicators of the very low-frequency spectrum of cardio intervals (VLF) and autonomic balance (LF/HF) of servicemen of the examined subgroups in a state of adaptation failure during test trials using different modes of strength loads, n=36

*Notes: * p< .05 – compared with the results recorded before the start of test trials (basal level)*

state of adaptation failure are observed. Concurrently, the question arises regarding the ability of the body systems of representatives of subgroups "B" to effectively implement short-term adaptation mechanisms in response to acute loads of different intensity. The results obtained will make it possible to clearly determine the resistance level of their body to a stress stimulus, as well as to identify possible manifestations of a functional overreaching state.

Fig. 2-4 present the features of changes in the indicators of spectral analysis of HRV and the studied blood biomarkers of participants of subgroups 1^B, 2^B, 3^B during test trials using different modes of strength loads. The obtained results will allow assessing the nature of adaptive and compensatory reactions of their body to an acute stimulus under conditions of different loads (R_a=0.56; R_a=0.68; R_a=0.78).

The results revealed in the course of the study (Fig. 2) indicate that the parameters of the VLF and LF/HF indicators demonstrate a completely different nature of changes among servicemen of subgroups "B" even in response to an identical stimulus. For example, the greatest decrease in the level of tension of heart rhythm regulation systems (LF/HF -47.6%) and simultaneous weakening of the central circuit (VLF -35.5%) were observed in subgroup 2B after loads in the mode R_a=68. After similar loads, in representatives of subgroup 1^B, on the contrary, there was a significant ($p<0.05$) increase in the VLF (+8.2%) and LF/HF (+30.0%) indicators. However, the effectiveness of the implementation of short-term adaptation mechanisms in response to loads in the mode R_a=0.78 was observed in representatives of subgroup 1^B (LF/HF -40.5%; VLF -10.8%). Among the participants of the other two groups, on the contrary, after similar loads, pronounced manifestations of compensatory mechanisms activation were recorded. An increase in the level of tension of the heart rhythm regulation systems (2^B +23.1%; 3^B +49.3%) and an increase in VLF power (2^B +4.1%; 3^B +11.5%) were observed. It was found that in response to loads in the mode R_a=0.56, the autonomic balance indicator shifts towards sympathetic activity in representatives of all three subgroups (1^B +44.9%; 2^B +7.1%; 3^B +19.8%). The corresponding changes indicate a low resistance level of their body systems to large-volume and low-intensity loads.

Investigating the nature of changes in the indicators of sympathetic and parasympathetic tone activity (Fig. 3) under the conditions of using different intensity and volume of load modes during testing, the following results were obtained. Thus, a simultaneous increase in LF power (+24.5%) and HF (+11.3%) was found in subgroup 2^B after loads in the mode R_a=68. A simultaneous decrease in the activity of sympathetic and parasympathetic tone in response to a stress stimu-

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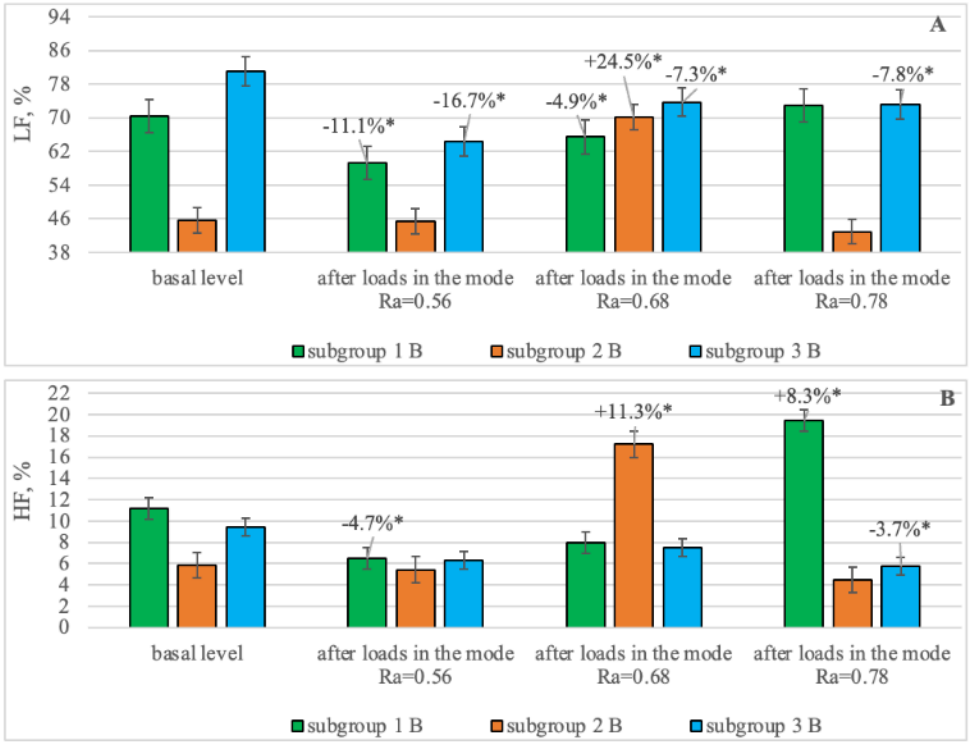

Fig. 3. Results of changes indicators of sympathetic activity (LF) and parasympathetic tone (HF) of HRV of servicemen of the examined subgroups in a state of adaptation failure during test trials using different modes of strength loads, n=36

*Notes: * p< .05 – compared with the results recorded before the start of test trials (basal level)*

lus was found in servicemen of subgroups 1^{B} (LF -11.1%; HF -4.7%) in the mode R_a=56. A similar direction of changes (LF -7.8%; HF -3.7%) was recorded in subgroup 3^{B} after loads in the mode R_a=78. It was established that only in representatives of subgroup 1^{B} in response to loads in the mode R_a=78, an increase in vagal influence (HF +8.3%) without changing LF power was recorded.

Fig. 4 presents the results of changes in the activity of enzymes CPK and LDH, as well as cortisol concentration in the blood serum of servicemen of the examined subgroups during test trials using different modes of strength loads.

It was established that in servicemen of subgroup 3^{B} in response to a stress stimulus, regardless of the load modes used, an increase in the activity of CPK and LDH above the upper limits of reference values is observed. After performing all three test trials, representatives of this subgroup showed a significant decrease in blood cortisol concentration by an average of 23.9% compared to the basal level. The corresponding changes indicate not only a low resistance level to all three load modes due to an imbalance in the functioning of the energy supply system, but also a possible state of functional overreaching.

It was found that in servicemen of subgroup 2^{B}, the activity of LDH in the blood serum increases beyond the reference range only in response to loads in the modes R_a=0.56 (+18.6%) and R_a=0.78 (+5.5%). A significant ($p<0.05$) decrease in cortisol concentration in similar modes in response to loads of medium (-28.8%) and high (-7.3%) intensity is recorded. At the same time, the activity of the enzyme creatine phosphokinase (CPK) in the blood serum of the participants of subgroup 2^{B}, when using these load modes, does not change. The obtained results clearly indicate the pronounced manifestations of activation of compensatory mechanisms in the body of the participants of this subgroup in response to such a stress stimulus.

The results of laboratory studies indicate that in representatives of subgroup 1^{B}, depending on the features of the load modes used during testing, a completely different nature of adaptive and compensatory reactions occurs. Thus, an increase in LDH activity in the blood serum even beyond the reference limits occurs only in response to loads in the modes R_a=0.56 (+30.3%) and R_a=0.68 (+23.2%). Such changes occur against the background of a significant decrease in cortisol concentration in the blood serum of the participants of this subgroup by an average of 43.9% ($p<0.05$) compared to the state of rest. At the same time, under the conditions of using a high-intensity load mode (R_a=0.78), an increase in CPK activity (+76.5%) and a simultaneous decrease in LDH (-21.3%) were recorded without changes in the level of cortisol concentration in the blood. It was during test trials in the load mode R_a=0.78 that

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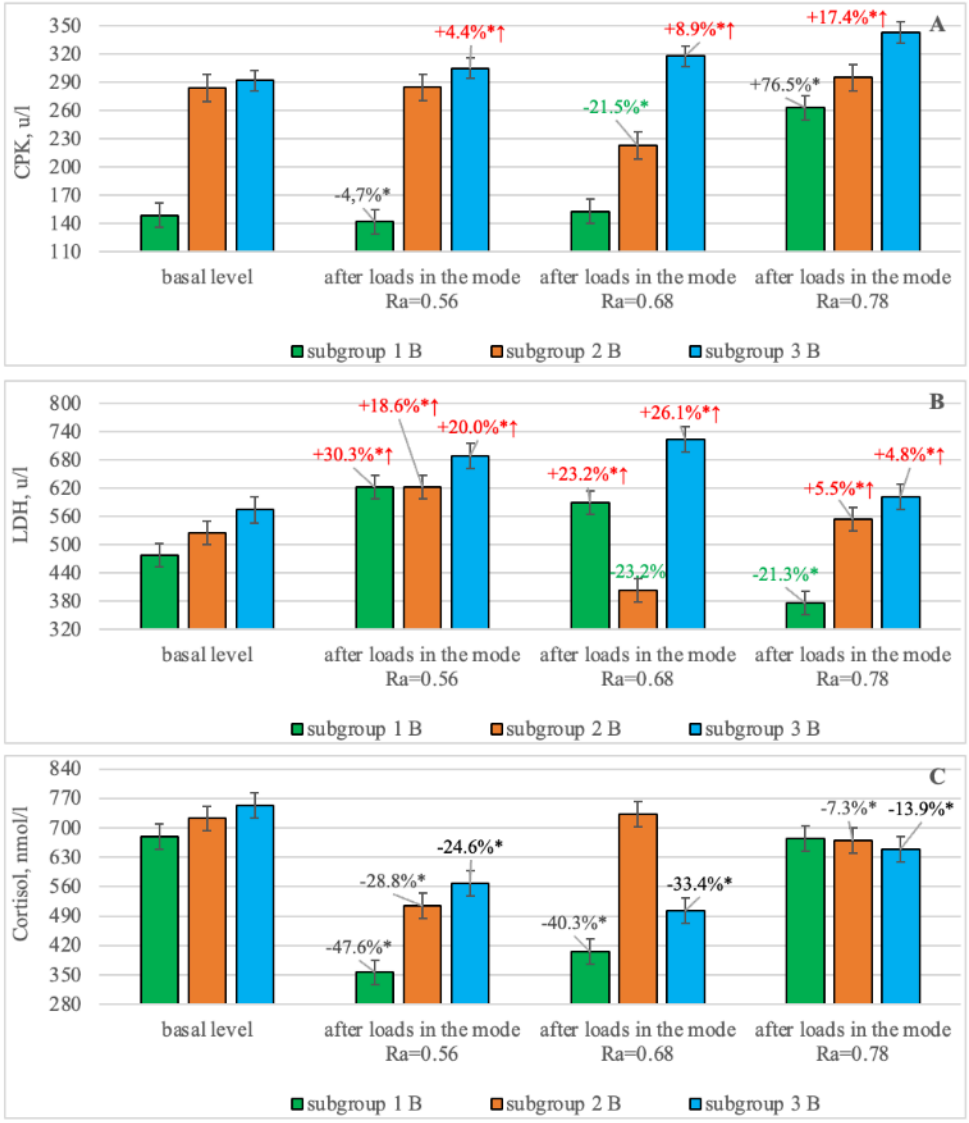

Fig. 4. Results of changes in the activity of enzymes CPK (A) and LDH (B), as well as cortisol concentration (C) in the blood serum of servicemen of the examined subgroups in a state of adaptation failure during test trials using different modes of strength loads, n=36

*Notes: * p< .05 – compared with the results recorded before the start of test trials (basal level); ↑ – exceeding the reference values of the studied blood biomarkers in the examined servicemen*

the effectiveness of the implementation of short-term adaptation mechanisms was observed in servicemen of subgroup 1^{B}.

Discussion

The paper presents the results of research on the search for effective mechanism for assessing the state of functional overreaching (FOR) in special operations forces servicemen against the background of adaptation failure after prolonged loads approaching the maximum in terms of volume and intensity. The features of changes in HRV indicators and blood biomarkers of the examined special operations forces servicemen in a state of adaptation failure under conditions of using load modes of different intensity and volume were studied. The obtained results reveal in more detail the scientific problem associated with the search for effective mechanisms for assessing adaptive and compensatory reactions in this category of individuals against the background of pronounced adaptation failure in response to a stress stimulus [16, 17]. Using indicators of spectral analysis of the heart rate and blood biomarkers, a step-by-step mechanism for assessing the initial state of the body systems after the previous training process was developed to identify possible manifestations of adaptation failure due to overtraining. The nature of changes in the resistance level to a corresponding stress stimulus was studied to assess the body's ability to effectively implement short-term adaptation mechanisms, or to record the state of functional overreaching [17]. The results we found complement scientific statements [10, 13] that using only the basal level of biochemical blood indicators and HRV of servicemen does not allow assessing the resistance

of the body systems to the stimulus, and simultaneously the state of FOR. The difficulty of clearly controlling the nature of adaptive and compensatory reactions in servicemen of special operations forces units under conditions of high-intensity loads against the background of possible adaptation failure or even functional overreaching is associated with an insufficient number of fundamental studies. At the same time, the complexity of this problem implementation is associated with the absence of a scientifically substantiated range of test trials that would take into account the adaptive reserves of servicemen of this category, the specifics of their training, and the possible consequences of systematic overload [4]. Accordingly, the absence of an optimal integral mechanism for the practical implementation of these problematic issues complicates the process of not only correcting training models, but also the very concept of readaptation of servicemen with manifestations of functional overreaching [6, 14]. The results indicate that in servicemen, regardless of the peculiarities of their special forces units, training system, and even the type of heart rhythm regulation, both a high level of functional capabilities and a state of adaptation failure are simultaneously recorded. In response to loads of different intensity and volume, in participants with pronounced adaptation failure, manifestations of both short-term adaptation mechanisms and compensatory reactions are recorded. The issue of determining the optimal spectrum of physiological and biochemical biomarkers for assessing adaptive and compensatory reactions, states of adaptation failure and FOR of special operations forces servicemen during training remains problematic [2, 7].

The results of the basal level of HRV indicators and the studied blood biomarkers obtained after the previous 3 months of high-intensity training differ significantly even within each of the three groups of special operations forces servicemen. It was established that 50% of servicemen of each unit, by the type of heart rhythm regulation, belong to normotensives, and the studied blood biomarkers are within the reference values. The obtained results indicate that servicemen with such basal parameters of the studied biomarkers, who were assigned to subgroups 1^{A}, 2^{A}, 3^{A}, have a high level of adaptive reserves [1, 10]. In the other part of the examined, the basal level of tension of the heart rhythm regulation systems was, on average, 5.4 times higher compared to opponents, and the basal level of biochemical blood parameters exceeded the upper limits of the reference. Such results of the basal level of the studied biomarkers, which were identified in servicemen of subgroups 1^{B}, 2^{B}, 3^{B}, indicate a possible state of adaptation failure [11, 18].

The study solved the issue of how effectively body systems in representatives of subgroups "B" implement short-term adaptation mechanisms in response to acute loads of varying intensity and under conditions of adaptation failure. It was established that in response to test trials using different load modes, servicemen of each subgroup demonstrated a completely opposite nature of adaptive and compensatory reactions. So, for example, in the first case, in response to a test load in the mode Ra=0.78 in representatives of subgroup 1B, a shift of the autonomic balance towards parasympathetic regulation with a simultaneous weakening in the VLF power is observed. Concurrently, there is an increase in the activity of creatine phosphokinase and no change in cortisol concentration in the blood serum to this stimulus. The corresponding nature of adaptive and compensatory reactions indicates the effectiveness of the implementation of short-term adaptation mechanisms in response to a stress stimulus and a high resistance level despite the state of adaptation failure [13, 17]. Otherwise, in servicemen of subgroup 1B in response to a test load in the mode Ra=0.56, a significant increase in the level of tension of the heart rhythm regulation systems, with a simultaneous strengthening of the central circuit (VLF) is observed. In response to such a stress stimulus, the activity of lactate dehydrogenase in the blood increases and exceeds the upper limits of the reference range, and cortisol concentration significantly decreases. Such changes indicate pronounced manifestations of compensatory reactions due to a low level of muscle glycogen reserves for the necessary energy supply of muscle activity, which led to the activation of gluconeogenesis processes [19, 20]. Thus, such a nature of adaptive and compensatory reactions to the given test loads indicates not only a low resistance level of body systems, but also functional overreaching (FOR) and the need for prompt correction of the training system [1, 21].

Conclusions

It was established that in servicemen, regardless of the peculiarities of their special operations forces units, training system and even the type of heart rhythm regulation, we simultaneously record both a high level of functional capabilities and a state of adaptation failure. It was investigated that the use of basal parameters of HRV indicators and biochemical blood indicators to determine the state of functional overreaching (FOR) in servicemen of special operations forces units with signs of adaptation failure is insufficient. It was found that in response to test trials using different load modes, servicemen

of each of the subgroups with adaptation failure recorded a completely opposite nature of adaptive and compensatory reactions. A decrease in the level of tension of the heart rhythm regulation systems and VLF power, the stability of cortisol level in the blood, and the absence of enzymes exceeding the reference limit in response to the stimulus, indicate the mechanisms of short-term adaptation. The effectiveness of the implementation of the mechanisms of short-term adaptation was recorded only in servicemen of subgroup 2^B (R_a=0.68) and in representatives of subgroup 1^B (R_a=0.78). In all other cases, a shift in the autonomic balance towards sympathetic activity was recorded against the background of strengthening the central circuit with a simultaneous increase in lactate dehydrogenase and a decrease in cortisol in the blood, which indicates compensatory reactions to the stimulus. The obtained results indicate that the resistance level and the state of functional overreaching recorded in servicemen against the background of adaptation failure is significant only under conditions of counteracting a certain stress stimulus (load mode). The identified features of the adaptive and compensatory reactions of the body of special operations forces servicemen against the background of adaptation failure to different intensity load modes require a radical correction of the process of optimizing the training system.

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Conflict of Interest
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