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Psychophysiological Indicators of Functional Efficiency of the Organism of Future Specialists in the Security and Defense Sector under Conditions of Extreme Loads

Nataliia Veronika Bachynska[1ABCDE], Eduard Doroshenko[2ABCD], Victor Bohuslavskyi[1BCDE], Volodymyr Vilianskyi[3ACDE], Ruslana Sushko[4ACDE], Igor Doroshenko[5BCD] and Oleksandr Didkovskiy[6BCDE]

[1]Dnipro State University of Internal Affairs
[2]Zaporizhzhia State Medical and Pharmaceutical University
[3]National University "Dnipro Polytechnic"
[4]Borys Grinchenko Kyiv Metropolitan University
[5]National University "Zaporizhzhia Polytechnic"
[6]Oles Honchar Dnipro National University

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Abstract

Objectives. Analysis and evaluation of psychophysiological indicators of functional efficiency of the organism of future specialists in the security and defense sector under the influence of extreme loads, considering individual adaptation capabilities.

Materials and Methods. The study population consisted of 240 cadets of the Dnipro State University of Internal Affairs (mean age 18.86 ± 1.25 years): control group (CG, n = 120), main group (MG, n = 120). The research procedure contains a set of valid psychophysiological methods used in studies of the adaptation of the body of people in extreme professions: Perceived Stress Scale (PPS-10); State-Trait Anxiety Inventory (STAI-S); Copenhagen Burnon Inventory: Personal Burnout (CBI-PB). Also used: Borg Scale of Perceived Exertion (BSPE); reaction time to light signal, milliseconds (ms); reaction rate (s); Stroop Test (ST); Hamilton Rating Scale for Depression (HRSD). Additionally, the following physiological indicators of the body were determined: Heart Rate (HR, b•m^{-1}), Blood Pressure (mm Hg), Pulse Oximetry (SpO_2), determination of cortisol levels in saliva (nnm•l^{-1}) before and after extreme load simulation (combination of physical and psycho-emotional stressors, close to operational conditions).

Results. The indicators of MG demonstrated the positive impact of the author's program on the body through physiological activation and stimulation of cognitive performance in stressful situations, which is a leading component of increasing the effectiveness of cadets' service training. The indicators of the body of MG cadets who underwent training under conditions of model extreme load have higher values of adaptive psychophysiological indicators compared to the body of CG cadets.

Conclusions. The preparation of future specialists in the security and defense sector for professional activity in extreme conditions is of a comprehensive nature, which includes physical, psychological, technical, tactical and special orientation, opportunities for the formation and improvement of social adaptation and effective teamwork.

Keywords: psycho-physiological indicators, functional efficiency, stress, adaptation, professional activity.

Introduction

Problematic issues of professional education remain in the focus of attention of specialists – scientists and practitioners of various profiles. One of the central places belongs to the urgent issues of rational organization of professional and applied physical training of future specialists: after all, it is clear that the deficit of physical fitness is a limiting factor in the practical implementation of professional knowledge, skills and abilities. In this context, the study of psychophysiological indicators of functional efficiency of the organism of future specialists in the security and defense sector of the country is significant.

Corresponding Author: Ruslana Sushko,
e-mail: rskarlet@ukr.net

Modern challenges in the field of security and defense lead to increased requirements for the professional training of future specialists, especially in conditions of increased psychophysiological stress (Du, 2025). Operational activities in real or simulated situations require employees not only high physical endurance, but also the ability to quickly adapt, maintain cognitive functions, withstand stress, and make effective decisions in conditions of information and time shortage (Kalnysh et al., 2025).

Scientific research by specialists confirms that the functional efficiency of the body in extreme conditions largely depends on the interaction of physiological parameters (cardiovascular, respiratory, neuroendocrine systems) and psycho-emotional reactions (anxiety, perception of stress, motivation). In this context, it is important to study integral indicators that reflect the adaptive capabilities of the body and allow predicting the effectiveness of professional activity in conditions of extreme exposure (Ukrainets, 2023; Prontenko et al., 2024; Kisil et al., 2025).

Also, relevant to solving this problem are the issues of forming and implementing psychological components – motivation, discipline and self-discipline (Pujianto et al., 2024), modified views on the role and significance of lactate in the process of extreme physical activity (Bielenichev et al., 2025). On this basis, prerequisites are created for optimal assessment of the correlation between indicators of strength and special fitness of the body in extreme conditions (Chernozub et al., 2023) and determination of the effectiveness of various models of functional efficiency of the body, considering the current level of physiological indicators (Banakh et al., 2025).

Despite the existing scientific developments, the dynamics of psychophysiological reactions and functional indicators in future specialists of the security and defense sector in simulated training conditions remains insufficiently studied. It is also relevant to establish relationships between subjective indicators of perception of physical and mental loads based on the determination of objective physiological changes, which will allow improving the control and correction systems of professional and applied physical training of future specialists of the security and defense sector.

Research into the impact of stress factors on the body, the dynamics of psychophysiological indicators, the impact of physical and mental stress on the efficiency of the work of future specialists in the security and defense sector is significant for their training and maintaining a high level of readiness of the body for the high-quality performance of professional duties in extreme situations.

Materials and Methods

Study Participants

The experimental research involved cadets of the Dnipro State University of Internal Affairs, who were divided into two groups: control (CG, n = 120) – male and female cadets who underwent training according to the standard training program without specialized training for activities in extreme conditions. The main group (MG, n = 120) underwent training for 10 months using a specialized training program for activities in extreme conditions. The average age of cadets CG and MG – 18.86 ± 1.25 years.

The experimental studies were conducted in accordance with the criteria of the World Medical Association (Declaration of Helsinki, 2008). All participants and parents of minors provided written consent to participate in the research and were informed about the purpose, objectives and testing procedures, as well as the possibility of withdrawing consent at any time for any reason.

Study Organization

Research objective – analysis and evaluation of psychophysiological indicators of functional efficiency of the organism of future specialists in the security and defense sector under the influence of extreme loads, taking in to account individual adaptation capabilities.

The research procedure contains a set of valid psychophysiological methods used in studies of the adaptation of the body of people in extreme professions: Perceived Stress Scale (PPS-10); State-Trait Anxiety Inventory (STAI-S); Copenhagen Burnon Inventory: Personal Burnout (CBI-PB). Also used: Borg Rating of Perceived Exertion (BRPE); reaction time to light signal, milliseconds (ms); reaction rate (s); Stroop Test (ST); Hamilton Rating Scale for Depression (HRSD). Additionally, the following physiological indicators of the body were determined: Heart Rate (HR, $b \bullet m^{-1}$), Blood Pressure (mm Hg), Pulse Oximetry (SpO_2), determination of cortisol levels in saliva ($nnm \bullet l^{-1}$) before and after extreme load simulation (combination of physical and psycho-emotional stressors, close to operational conditions).

Statistical Analysis

Statistical processing was carried out using "Statistica", version 10.0 computer program and MS Excel XP software packages with an open license for non-commercial use. The main indicators of mathematical statistics: arithmetic mean (X), standard deviation (SD), standard error of the arithmetic mean (m), Pearson correlation coefficient (r). Comparison of indicators between samples (control and main group for cadets of different sexes) was carried out using the non-parametric statistical U-criterion Mann – Whitney (in cases of absence of normal distribution in the sample) and Student's t-criterion (in cases of presence of normal distribution in the sample). In mathematical and statistical processing, the significance level $\alpha = 0.05$ ($p < 0.05$) was used, in some cases the results were obtained at higher significance levels ($p < 0.01$ and $p < 0.001$).

Results

The experimental part of the research included modeling of stressful situations with parallel performance of physical exercises and subsequent monitoring of the body's adaptive reactions before and after specific loads (stress factors). This allowed us to determine the dynamics of psychophysiological indicators of the cadets' body under the influence of stress factors and extreme factors.

For stress assessment in future specialists in the security and defense sector using psychological tests and determining physiological indicators of the body a number of experimental studies have been carried out. In the process of comprehensive characterization of the psychophysiological stress of

the body of cadets of the 1st – 3rd courses (n = 240), standardized psychological questionnaires were combined with objective somatic indicators, which were measured at rest and after standardized physical exertion (long running in place – 3 min, 70% HR_max, which allows assessing the physiological response to moderate stress, measuring heart rate, indicators of muscle fatigue and changes in emotional state).

In the process of conducting experimental research, three validated scales were used, which are used by specialists for psychological assessment of representatives of the security and defense sector, namely:

1) Perceived Stress Scale (PPS-10);

2) State-Trait Anxiety Inventory Scale, part "state" (STAI-S to assess the level of anxiety that the subjects (cadets) experienced at the time of the examination, which is important before and after physiological stress);

3) Copenhagen Burnout Inventory scale (CBI-PB) (Mazhak et al., 2024).

High internal consistency rates (α = 0.82 – 0.91) confirmed the reliability of the Ukrainian versions of psychodiagnostic questionnaires (Kudryavtsev et al., 2016).

To study the psycho-emotional state of cadets in the dynamics of physiological stress, comprehensive testing was conducted using validated psycho-diagnostic tools (Table 1).

Table 1. The value of psychological indicators of the cadets' body CG (n = 120) and MG (n = 120), (X ± SD), n = 240

Scale	Group	1 test	2 test	P_1*	P_2**
PSS-10	CG	18.52 ± 4.22	25.74 ± 4.89	< 0.01	≥ 0.05
	MG	18.30 ± 3.98	20.88 ± 4.14	< 0.05	< 0.01
STAI-S	CG	42.68 ± 5.36	51.28 ± 5.92	< 0.01	≥ 0.05
	MG	42.12 ± 5.15	46.04 ± 5.46	< 0.05	< 0.01
CBI-PB	CG	37.94 ± 6.76	45.12 ± 7.03	< 0.01	≥ 0.05
	MG	38.25 ± 6.32	40.68 ± 6.81	< 0.05	< 0.01

Notes: * – values before and after experimental studies; ** – the value of the control and main groups after conducting experimental studies

Table 2 provides a comparative description of the physiological indicators of future specialists in the security and defense sector in the context of determining changes in the physiological indicators of the body under the influence of performing specific physical activity.

Table 2. The value of physiological indicators of the cadets' body CG (n = 120) and MG (n = 120), (X ± SD)

Indicators	Group	1 test	2 test	p*
HR, b•m^{-1}	CG	72.34 ± 4.22	134.65 ± 7.14	< 0.01
	MG	71.84 ± 4.37	122.35 ± 5.96	
BPs, mm Hg	CG	118.96 ± 6.06	148.88 ± 7.46	< 0.05
	MG	119.42 ± 5.80	138.92 ± 6.24	
BPd, mm Hg	CG	76.87 ± 4.34	91.28 ± 5.28	< 0.05
	MG	77.12 ± 4.11	85.65 ± 4.43	
PO (SpO_2), %	CG	98.02 ± 1.05	95.12 ± 1.72	< 0.01
	MG	97.12 ± 0.98	93.37 ± 1.36	
Δ HR_120 s, b•m^{-1}	CG	–	30.78 ± 4.18	< 0.001
	MG	–	41.26 ± 5.24	

Notes: * – the value of the control and main groups after conducting experimental studies; the value "p" was calculated using the Student's-test for independent samples; Δ HR_120 s, b•m^{-1} – recovery rate assessment

Correlation analysis of experimental indicators showed (Table 3) that increased subjective stress levels are accompanied by higher cardiovascular reactions and slower recovery of the psychological state of the body.

Table 3. Correlation analysis of physiological and psychological parameters of future security and defense sector specialists in extreme conditions, n = 240

Grouping variables	r	p
PSS-10 & HR, (b•m^{-1}) after load	0.53	< 0.001
PSS-10 & Δ HR_120 s, (b•m^{-1})	0.48	< 0.001
STAI-S & BPs, (mm Hg) after load	0.39	< 0.001
CBI-PB & PO (SpO_2), (%) after load	- 0.36	< 0.01

The indicators obtained in the process of correlation analysis allow us to state that future specialists in the security and defense sector with a significant impact of stress factors demonstrated a more intense cardiovascular response of their body and, accordingly, lower saturation levels during specific physical exertion, as well as slower chronological periods of restoration of the functioning of the cardiovascular system.

Based on the above, we state that a comprehensive combination of psychological and non-invasive tests with operational instrumental measurements is an effective screening technology for early identification of cadets with increased stress vulnerability of the body and timely correction of the proposed individual training programs.

The results of testing the cognitive sphere of cadets according to the indicators of the Stroop test and the stimulus response test for the control and experimental groups before and after the experiment, taking into account statistically significant differences, are presented in Table 4. To assess the reaction time to a given stimulus (light, sound), a psychodiagnostic computer complex ("Diagnost", ms) was used.

According to the subjective stress scale (BRPE, Borg Rating of Perceived Exertion), which reflects the feeling of shortness of breath, fatigue, and heaviness, an assessment of the intensity and perception of stress by the body of future specialists in the security and defense sector was carried out using a questionnaire after performing a series of exercises (Table 5).

In the body of cadets CG, insignificant changes in BRPE indicators were found, which did not reach statistical significance (p > 0.05), which indicates the relative stability of the perception of the load, presumably due to the standard nature of the influences. In the body of cadets MG, after applying the author's model, a statistically significant increase in subjective load was recorded, namely: in the group of men and the group of women with a significance of p < 0.01 (Table 5). The results obtained indicate the fact that the developed training model causes a higher level of involvement and was perceived by the body of cadets as more intense and psychologically more stressful.

In the CG, a slight increase in indicators was observed in men after the experiment, which is not statistically significant. In the MG, a statistically significant increase in BRPE indicators was found in male and female cadets after the experiment compared to baseline data (p < 0.01).

Also significant is the fact that despite the increased workload, the cadets in the MG did not show signs of fatigue and there was a parallel improvement in physiological and

Table 4. Comparative characteristics of changes in indicators of the cognitive sphere of the body of cadets of the CG and MG after the experiment, (X ± SD), n = 240

Indicators	Groups	Before the experiment X ± SD	After the experiment X ± SD	p	Comment
Reaction time to light signal, ms	CG	304.12 ± 22.87	301.87 ± 21.20	> 0.05	no changes
	MG	307.76 ± 24.65	275.18 ± 18.78	< 0.01	increasing reaction speed
Stroop test, s	CG	36.23 ± 3.38	35.78 ± 3.21	> 0.05	no changes
	MG	37.05 ± 3.69	32.54 ± 2.92	< 0.01	improving concentration
Stroop test, n	CG	2.24 ± 1.13	2.18 ± 1.09	> 0.05	performance stability
	MG	2.51 ± 1.21	1.47 ± 0.94	< 0.05	improving attention control

Notes: Stroop test, s – test execution time indicator; Stroop test, n – error number indicator

Table 5. Indicators of subjective assessment of the state of the body of cadets of different sexes according to the Borg scale (BRPE), (X ± SD), n = 240

Groups	Gender	Before the experiment	After the experiment	p
CG	men	13.19 ± 1.42	13.36 ± 1.44	> 0.05
	women	13.59 ± 1.52*	13.79 ± 1.63*	> 0.05
MG	men	13.60 ± 1.64	15.81 ± 1.29	< 0.01
	women	13.92 ± 1.51	16.28 ± 1.56*	< 0.01

Notes: 1) differentiation according to the Borg scale: "≥ 6.0" – very easy; "6.1-9.0" – easy; "9.1-13.0" – moderate; "13.1-15.0" – difficult; "15.1-17.0" – very difficult; "17.1-20.0" – maximum; 2) * – statistically significant differences between the groups of women and men ($p < 0.05$)

cognitive indicators, which confirms the adaptive nature of their body's reaction.

One of the leading factors that determine the functional state of the body under the influence of stress factors is the level of cortisol – the main stress hormone, which affects the regulation of blood pressure indicators, metabolism, cognitive functions and psychological reactions to threat. Cortisol imbalance can lead to short-term disruptions in the functioning of the body: decreased attention, errors in assessing situations, psycho-emotional disorders, emotional burnout and reduced combat effectiveness in extreme situations (Sekel et al., 2023).

Studying the cortisol profile in future specialists in the security and defense sector is a scientifically sound and practically significant direction for increasing the efficiency of their professional activities, which provides new modern opportunities for creating a system for early diagnosis of dead-aptation of the cadets' body.

Monitoring the cortisol level of future specialists in the security and defense sector is an important part of the medical and biological support of their professional and applied physical training. Determining the cortisol level, the dynamics of its changes during training, when modeling extreme situations allows you to carry out procedures for end-to-end operational control:

- assessment of the body's adaptive capabilities;
- identifying individual differences in stress resistance indicators.
- correction of indicators of physical and psychological stress in the educational process;
- development of differentiated psychophysiological training programs;
- prevention of overfatigue, chronic stress and post-traumatic reactions.

Table 6 presents the dynamics of the results of the level of cortisol in saliva in male and female cadets who participated in the pedagogical experiment, in the CG and MG (MG cadets trained in conditions of simulation of extreme conditions according to the author's program for 10 months).

Table 6. Indicators of the level of cortisol in saliva of cadets, nnm•l^{-1}, (X ± SD), n = 240

Group	Gender	Experimental period: before the experiment	Experimental period: after the experiment	p_1	p_2
CG	men	15.06 ± 3.45	24.14 ± 4.32	$p < 0.01$	$p \geq 0.05$
	women	14.34 ± 3.66	23.31 ± 4.51	$p < 0.01$	$p \geq 0.05$
MG	men	14.94 ± 3.20	19.78 ± 3.96	$p < 0.01$	$p < 0.01$
	women	14.62 ± 3.24	18.42 ± 3.92	$p < 0.01$	$p < 0.01$

Notes: p_1 – gender difference in the group (before and after the experiment); p_2 – difference in the control and main groups (before and after the experiment)

Table 7 presents data from a comparative analysis of the psychophysiological state and functional efficiency of cadets under stressful conditions.

Table 8 presents the correlations between psychological indicators, namely stress, anxiety, burnout and physiological parameters (HR; b•m^{-1}), blood pressure (mmHg), O_2 satura-

Table 7. Comparative data on the psychophysiological state and functional efficiency of future specialists in the security and defense sector under stressful conditions, n = 240

Indicators	1 test	2 test	p	Δ, %
level of cortisol in saliva, nnm•l^{-1}	15.76 ± 2.41	9.64 ± 1.92	< 0.01	- 38.8 %
stress level according to the Hamilton scale, points	22.63 ± 4.12	15.24 ± 3.67	< 0.05	- 32.7 %
reaction rate, s	0.46 ± 0.05	0.34 ± 0.04	< 0.05	- 26.1 %
intermuscular coordination, N•m	20.22 ± 3.78	12.76 ± 2.32	< 0.01	+ 36.9 %
mistakes in stressful situations, n	4.65 ± 1.23	2.32 ± 1.14	< 0.05	- 50.1 %
duration of task performance under the influence of stress factors, s	3.34 ± 0.58	5.28 ± 0.89	< 0.01	+ 58.1 %

Notes: 1 test – to the implementation of the author's program; 2 test – after the implementation of the author's program

tion (%), cortisol level (nnm•l^{-1}) in cadets after controlled physical activity, which included running in place, 3 min., 70% HR_max.

Table 8. Correlations between psychological and physiological indicators of cadets after controlled physical activity, (r), n = 240

Indicators	HR, (b•m^{-1}) after load	BPs, (mm Hg)	BPd, (mm Hg)	PO (SpO_2), (%)	Level of cortisol in saliva, (nnm•l^{-1})
PSS-10	0.42*	0.36*	0.33*	- 0.26	0.45**
STAI-S	0.54**	0.48**	0.40*	- 0.36*	0.50**
CBI-PB	0.32*	0.28	0.24	- 0.20	0.40*

Notes: 1) * – statistically significant relationship, $p < 0.05$; 2) ** – statistically significant relationship, $p < 0.01$

The analysis of the obtained data revealed a moderate positive relationship between the level of anxiety STAI-S and HR, (b•m^{-1}) after load, which may indicate vegetative activation of the body in response to emotional stress. Stress (PSS-10) and burnout (CBI-PB) indicators also positively correlate with the muscle fatigue indicator, which may indicate reduced tolerance to exercise in future security and defense sector specialists with high psycho-emotional exhaustion.

Possible hyperventilation or ineffective breathing in a state of emotional tension is indicated by the negative correlation between saturation PO (SpO_2), (%) and stress, especially regarding STAI-S anxiety ($r = - 0.36$, $p < 0.05$).

As part of the experimental methodology, modeling of stressful situations (combat operations, emergencies) based on virtual simulators, monitoring of cortisol levels, stress levels using special scales, assessment of stress reactions and control of emotions in real time are proposed.

Stages of implementation of the author's program for correcting psychophysiological indicators of future security sector specialists in conditions of modeling extreme situations:

- modeling of stressful situations (combat, emergencies) based on the use of virtual simulators;
- monitoring of cortisol levels, stress levels using special scales, assessment of stress reactions and control of emotions in real time;
- assessment of stress reactions and expert interpretation of the obtained indicators;
- improving results based on the implementation of the author's program.

The professional activities of future security and defense professionals require a high level of physical endurance, stress resistance, and psychological stability (Stern et al., 2019). To successfully adapt the cadets' bodies to extreme conditions and effectively perform their duties in high-risk environments, it is necessary to develop a comprehensive training methodology that includes physical, technical, psychological, and social areas.

Recommendations for improving the training of future security and defense professionals to work in extreme conditions:

1. physical training:
- development of strength and endurance
- control of the physical state of the body;
2. psychological training:
- improving stress resistance;
- orming team interaction;
3. technical training:
- mastering special skills and abilities;
- effective work in conditions of limited resources;
4. social adaptation and support:
- promoting team interaction and working in variable coalitions;
- forming and developing skills for making effective decisions in stressful situations;
- psychological support of social processes and events;
5. control and correction:
- control of physical, physiological and psychological states;
- assessment of the effectiveness of individual training programs;
- correction of individual training programs.

One of the key indicators of the body's stress response is the level of cortisol in saliva, which reflects the activation of the hypothalamic-pituitary-adrenal axis under the influence of psycho-emotional and physiological stress. Before the experiment, the average level of cortisol in the CG and MG was practically the same, which indicates the initial homogeneity of the sample. After modeling extreme conditions using the author's method (stress test), the level of cortisol in the CG increased significantly, which is a typical indicator of an acute stressful situation for the body – this confirms the effectiveness of the special stress scenario and the corresponding training program.

The use of the author's method in the main group allowed to reduce the intensity of the stress response of the cadets' body. This is evidenced by a smaller increase in cortisol compared to similar indicators of the body of the cadets of the CG. This indicates the feasibility of implementing the author's methodology into the system of training future specialists in the security and defense sector to increase their functional resistance to stress. A statistically significant difference between the groups was recorded after the experiment ($p < 0.01$).

The experimental results obtained after modeling the impact of extreme situations recorded a significant increase in cortisol levels ($p < 0.01$), which is a typical physiological reaction of the body to the impact of stress factors.

However, the nature of this reaction in the representatives of the CG and MG turned out to be different. In the CG, both men and women demonstrated a more pronounced increase in cortisol, which indicates reduced levels of adaptation and unformed stress resistance skills. In contrast, in the MG, whose participants underwent special training according to the author's program, the reaction was more noticeable, and the cortisol level after exposure remained at a lower statistically significant level than in the cadets of the CG ($p < 0.01$).

The experimental results obtained confirm the effectiveness of the author's program of special physical training for actions in conditions of increased emotional stress. The decrease in hormonal reactivity can also be considered as a positive result of the formation of adaptive mechanisms that are necessary to ensure effective professional activity in stressful conditions, regardless of gender.

Psychological assessment of anxiety and stress level according to the Hamilton scale after the experiment indicates

a decrease in the level of anxiety in the cadets. Indicators of assessment of proprioceptive sensitivity and intermuscular coordination (differential dynamometry at the level of 50% of the maximum) indicate a statistically significant improvement.

The reduction in the number of errors in stressful situations in the MG indicates a decrease in the level of stress and an increase in the ability to adapt to future specialists in the field of emergency medical services and defense. Special endurance was studied to assess the time during which the participants of the experiment can perform tasks under increased stress. A statistically significant increase in the time of task completion indicates an improvement in the special endurance and adaptive capabilities of the cadets' body under the influence of stress.

The data obtained indicates the effectiveness of the author's methodology in improving psychophysiological qualities (work on improving cognitive functions, special exercises for controlling stress and anxiety), which is critically important for professional activity in conditions of significant physical exertion and the influence of extreme situations. This is why regular assessment of the results of training of future specialists with ongoing correction of training programs is necessary.

Discussion

The elements of scientific novelty of the study are the integration of psychological and physiological approaches to the study of the complex impact of stress factors and special physical exertion on the effectiveness of professional activity of future specialists in the security and defense sector.

The study of stress, its neurophysiological mechanisms and psycho-emotional adaptation of the body in conditions of increased danger is a priority area of professional and applied physical training of future specialists in the security and defense sector. One of the most thorough is the study of (Akil, & Nestler, 2023; Shmyrko et al., 2021; Tyshchenko et al., 2023), which emphasizes the leading role of brain structures in the organization of stress responses and adaptive changes in the body. Researchers have also studied chronic stress as a neurobiological factor that can cause dysfunction in the emotional, cognitive, and immune spheres (Mazhak et al., 2024).

In an applied sense, these processes are reflected in the studies of specialists (Flood, & Keegan, 2022), who studied individual variations of stressful situations in the security and defense sector, emphasizing that the high intensity of combat missions directly correlates with the level of anxiety and a decrease in the quality of their performance. A similar issue was studied by (Aleshchenko, & Kokun, 2025), in the study of cognitive loads during extreme situations as a dominant factor of deadaptation.

At the same time, a few scientific studies are aimed at determining the adaptive potential of security and defense sector specialists. In particular, (McClung et al., 2023) focuses on psychophysiological factors of stress resistance, among which the leading place is occupied by the interaction between cardiovascular regulation, emotional stability and the level of neurocognitive control. Similar conclusions are confirmed by (Kirkham et al., 2025), who studied the states of cognitive and emotional stability as critical variables of professional effectiveness. Using the example of military medicine, similar experimental data were obtained (MacEwan, & Gibson, 2021).

Modern approaches to increasing the body's stress resistance are based on training cognitive and emotional skills. In particular, (Lee et al., 2025), prove the effectiveness of cognitive training in increasing the body's tolerance to stress and regulating emotions in military cadets. The study (Ishchenko et al., 2024) notes that the development of emotional intelligence increases the ability to adapt to combat stress and provides better behavioral adaptation. It is also worth highlighting the study (Hepner et al., 2024), which analyzes the impact of innovative approaches and technologies on reducing the level of psychological stress and increasing the body's cognitive performance.

In addition, the study (Bohuslavsky et al., 2024) highlights the stress-producing factors of the activities of law enforcement agencies in Ukraine, with an emphasis on the need to form special physical and psychological training for actions in extreme conditions.

Researchers note that the professional training of future security and defense sector specialists involves at least two dominant components, including 1) the development of physical endurance and technical skills; 2) the formation of psychological resilience to stressful situations (Oliinyk et al., 2025; Chaban et al., 2024).

The analysis of a few scientific and methodological sources confirmed the reliability and validity of the scales used in the studies, in conditions of increased stress, which is characteristic of the formation of professional competence of future specialists in the security and defense sector (Ghasemi et al., 2024; Ilardo, & Nielsen, 2018; Veldbrekht, & Tavrovetska, 2022).

The obtained experimental results of the study confirm that the introduction of special (professionally applied) physical training into the educational and training process allows significantly improving the adaptive reactions of the cadets' body to the effects of extreme loads, reduces physiological stress, and promotes faster recovery after performing complex official tasks.

Thus, the current scientific discussion outlines a few key areas, namely: cognitive load and combat mission performance; neurophysiological mechanisms of stress; psychophysiological markers of stress tolerance; effectiveness of cognitive and mindfulness interventions; gender and sociocultural characteristics of stress perception (Binková, & Štěpánková, 2025). Systematic integration of these approaches into the training program of future security and defense sector specialists can significantly increase their effectiveness in conditions of combat or crisis load (Çelik, 2025; Spytska, 2024; Shvets et al., 2024).

Based on the experimental results obtained, practical recommendations are proposed for improving the training of cadets – future specialists in the security and defense sector: formation, testing and improvement of programs for the development of stress resistance, implementation of control of the psychophysiological state of the cadets' body at different stages of the training process. The above will contribute to increasing the adaptive potential of future specialists in the security and defense sector for effective activity in extreme conditions.

The prospects for further scientific exploration in this direction are based on the need to further study the complex impact of psychophysiological factors on the body of future specialists in the security and defense sector to improve their professional and applied physical fitness for the successful implementation of official tasks under the influence of extreme factors.

Conclusions

As a result of experimental measurements, it was found that future specialists in the security and defense sector demonstrate a moderate level of stress (PSS-10), increased situational anxiety (STAI-S) and signs of professional burnout (CBI-PB). This indicates the presence of psycho-emotional tension, which potentially reduces the effectiveness of professional activity in extreme conditions.

The results of physiological measurements demonstrate a significant improvement in heart rate indicators (HR; b•m^{-1}), a decrease in blood oxygen saturation (PO (SpO2), %) and an increase in salivary cortisol concentration after specific exercise (nnm•l^{-1}), which confirms the activation of the body's stress responses.

Cadets also observed a slower recovery of heart rate (Δ HR_120 s; b•m^{-1}), which may indicate a decrease in autonomic regulation reserves.

The complex impact of stress factors and physical exertion on the muscular system of cadets led to an increase in muscle fatigue indicators, a decrease in the accuracy of movements and intermuscular coordination, as well as an increase in the number of errors when performing tasks under stressful conditions. The endurance indicator correlated with the level of situational anxiety and the concentration of cortisol in saliva, which confirms the relationship between psycho-emotional stability and functional efficiency of the body.

Statistically significant correlations between psychological parameters and physiological reactions of the body were found, which allows us to interpret adaptation to the load as an integrated process. Correlations between anxiety and saturation indicators, as well as between the level of cortisol in saliva and the slowed recovery of heart rate confirm the importance of a comprehensive assessment of the physical condition of the cadets.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Психофізіологічні показники функціональної ефективності організму майбутніх фахівців сектору безпеки і оборони в умовах екстремальних навантажень

Наталія Вероніка Бачинська[1ABCDE], Едуард Дорошенко[2ABCD], Віктор Богуславський[1BCDE], Володимир Вілянський[3ACDE], Руслана Сушко[4ACDE], Ігор Дорошенко[5BCD], Олександр Дідковський[6BCDE]

[1] Дніпровський державний університет внутрішніх справ
[2] Запорізький державний медико-фармацевтичний університет
[3] Національний університет «Дніпровська політехніка»
[4] Київський столичний університет імені Бориса Грінченка
[5] Національний університет «Запорізька політехніка»
[6] Дніпровський національний університет імені Олеся Гончара

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 8 табл., 35 джерел.

Мета. Аналіз і оцінювання психофізіологічних показників функціональної ефективності організму майбутніх фахівців сектору безпеки і оборони під впливом екстремальних навантажень з урахуванням індивідуальних адаптаційних можливостей.

Матеріали та методи. Досліджувану вибірку становили 240 курсантів Дніпровського державного університету внутрішніх справ (середній вік — 18,86 ± 1,25 року): контрольна група (КГ, n = 120) та основна група (ОГ, n = 120). Процедура дослідження включала комплекс валідних психофізіологічних методик, що застосовуються у вивченні адаптації організму осіб екстремальних професій: шкала сприйманого стресу (PPS-10); інвентар стану й особистісної тривожності (STAI-S); Копенгагенський індекс вигорання: особистісне вигорання (CBI-PB). Також використовувалися: шкала суб'єктивного відчуття навантаження Borg (BSPE); час реакції на світловий сигнал, мс; швидкість реакції, с; тест Струпа (ST); шкала депресії Гамільтона (HRSD). Додатково визначалися такі фізіологічні показники організму: частота серцевих скорочень (ЧСС, уд·хв$^{-1}$), артеріальний тиск (мм рт. ст.), пульсоксиметрія (SpO_2), рівень кортизолу в слині (нмоль·л$^{-1}$) до та після моделювання екстремального навантаження (поєднання фізичних і психоемоційних стресорів, наближених до службово-операційних умов).

Результати. Показники ОГ продемонстрували позитивний вплив авторської програми на організм через фізіологічну активацію та стимуляцію когнітивної працездатності у стресових ситуаціях, що є провідним компонентом підвищення ефективності службової підготовки курсантів. Показники організму курсантів ОГ, які проходили підготовку в умовах модельованого екстремального навантаження, мають вищі значення адаптивних психофізіологічних показників порівняно з курсантами КГ.

Висновки. Підготовка майбутніх фахівців сектору безпеки і оборони до професійної діяльності в екстремальних умовах має комплексний характер і охоплює фізичну, психологічну, технічну, тактичну та спеціальну спрямованість, а також створює можливості для формування й удосконалення соціальної адаптації та ефективної командної взаємодії.

Ключові слова: психофізіологічні показники, функціональна ефективність, стрес, адаптація, професійна діяльність.

Information about the Authors:

Bachynska, Nataliia Veronika: nat3vero@gmail.com; https://orcid.org/0000-0002-0448-9187; Department of Special Physical Training, Dnipro State University of Internal Affairs, Nauky Ave, 26, Dnipro, 49005, Ukraine.

Doroshenko, Eduard: doroe@ukr.net; https://orcid.org/0000-0001-7624-531X; Department of Physical Rehabilitation, Sports Medicine, Physical Education and Health, Zaporizhzhia State Medical and Pharmaceutical University, Mayakovsky St, 26, Zaporizhzhia, 69035, Ukraine.

Bohuslavskyi, Victor: d_spt@dduvs.edu.ua; https://orcid.org/0000-0003-2688-4505; Department of Special Physical Training, Dnipro State University of Internal Affairs, Nauky Ave, 26, Dnipro, 49005, Ukraine.

Vilianskyi, Volodymyr: vilianskyi.v.m@nmu.one; https://orcid.org/0000-0002-2550-2643; Department of Physical Education and Sports, National Technical University "Dnipro Polytechnic", Dmytra Yavornytskoho Ave, 19, Dnipro, 49005, Ukraine.

Sushko, Ruslana: r.sushko@kubg.edu.ua; https://orcid.org/0000-0003-3256-4444; The Faculty of Health, Physical Training and Sports, Borys Grinchenko Kyiv Metropolitan University, Levka Lukyanenko St, 13-B, Kyiv, 04212, Ukraine.

Doroshenko, Igor: metallurg19u@gmail.com; https://orcid.org/0000-0003-0600-2798; Department of Physical Culture, Olympic and non-Olympic sports, National University "Zaporizhzhia Polytechnic", Zhukovsky St, 64, Zaporizhzhia, 69063, Ukraine.

Didkovskiy, Oleksandr: didkovskiy1193@gmal.com; https://orcid.org/0000-0001-5268-5599; Department of Physical Education and Sports, Oles Honchar Dnipro National University, Nauky Ave., 72, Dnipro, 49005, Ukraine.

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