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Perception of operational environment conditions and situations as a prediction of adaptive potential in servicemen

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The aim of the study is to define the adaptive potential of servicemen participating in warfare based on the formation of their perceptions related to operational environment conditions and characteristics of heart rate variability (HRV).

Materials and methods. 70 combatants – men aged 22–30 years were examined. According to a specially designed questionnaire that reflected the issue of combat and deployment life factors among servicemen in the operational environment, an assessment of their perceptions related to the impact of internal and external factors was conducted. The HRV parameters of the studied servicemen were determined by standard methods using computer rhythmograph. Statistical analysis of the data was performed using the methods of parametric (Student's t-test) and non-parametric statistics (Wilcoxon's T-test), cluster, step-by-step multiple correlation and step-by-step discriminant analysis using software package Statistica 13.3.

Results. The studied contingent was divided into two "hypersusceptible" and "hyposusceptible" groups based on the use of their perceptions related to the operational environment factors. It has been noted that group 1 had greater values of median profiles than group 2. The differentiation of the studied contingent into groups of "hypersusceptible" and "hyposusceptible" to harmful operational environment factors was more noticeable when applying criteria of deployment life factors. HRV values (LFnorm, HFnorm and LF/HF) differed significantly in both examined groups. It has been found that the multiple correlation coefficient value for group 1 was $R = 0.61$ ($P < 0.007$), and for group 2 – $R = 0.83$ ($P < 0.00009$), indicating the presence of a stronger link between the level of adaptability and the parameters of heart rate regulation among "hyposusceptible" servicemen. The developed decisive rules allow identifying the adaptive potential level in servicemen by assessing the effects of combat factors and deployment life.

Conclusions. Among the operational environment factors, the deployment factors have been found to be the most significant, suggesting that these characteristics were the most susceptible to harmful operational environment factors in combatants. The analysis of the HRV characteristics in servicemen with "hypersusceptibility" and "hyposusceptibility" to the operational environment factors has shown the higher adaptive potential in representatives of "hyposusceptible" serviceman group. The decision support model for individual assessment of the adaptive potential of servicemen according to the parameters of their perceptions of the operational environment factors (combat and deployment life factors) has been developed.

Ключові слова: військовослужбовці, адаптаційний потенціал, чутливість до чинників операційного середовища, гіперчутливість, гіпочутливість, варіабельність серцевого ритму.

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Сприйняття впливу умов і ситуацій операційного середовища як відображення адаптаційного потенціалу військовослужбовців-учасників бойових дій

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Мета роботи – встановити адаптаційний потенціал організму військовослужбовців-учасників бойових дій на основі формування їхніх вражень від умов операційного середовища та характеристик варіабельності серцевого ритму.

Матеріали та методи. Обстежили 70 комбатантів, чоловіків віком 22–30 років. За спеціально розробленою анкетою, що передбачала запитання щодо бойових і побутових проблем, які виникли у військовослужбовців у зоні проведення бойових дій на початку збройного конфлікту на Сході України, оцінили їхні враження щодо дії факторів внутрішнього та зовнішнього середовища. За допомогою комп'ютерного ритмографа визначили параметри варіабельності серцевого ритму обстежених військовослужбовців за стандартними методами. Статистичний аналіз даних здійснили, застосувавши методи параметричної (t-критерій Стьюдента) та непараметричної статистики (t-критерій Вілкоксона), кластерного, покрокового множинного кореляційного та покрокового дискримінантного аналізу з допомогою пакету програм Statistica 13.3.

Результати. Контингент обстежених поділили групи «гіперчутливих» і «гіпочутливих» військовослужбовців, ґрунтуючись на їхніх враженнях про дію факторів операційного середовища. Виявили, що в цьому разі група 1 має більші значення медіан профілів, ніж група 2. Поділ контингенту на групи умовно «гіперчутливих» і «гіпочутливих» до дії шкідливих факторів середовища більш виражений у разі застосування критеріїв побуту. Показники ВСР (LFnorm, HFnorm і LF/HF) вірогідно відрізнялися у групах дослідження. Встановлено, що величина множинного коефіцієнта кореляції для групи 1 становить $R = 0{,}61$ ($p < 0{,}007$), а для групи 2 – $R = 0{,}83$ ($p < 0{,}00009$). Це свідчить про наявність сильнішого зв'язку між рівнем адаптивності та параметрами серцевого ритму «гіпочутливих» військовослужбовців. Розроблені правила дають змогу встановити рівень адаптаційного потенціалу військовослужбовця за оцінками відчуттів дії на нього факторів бойового середовища і життєзабезпечення.

Висновки. Найважливішими з-поміж факторів операційного середовища були чинники побуту, а отже ці характеристики можна вважати найбільш чутливими до дії шкідливих факторів довкілля в учасників бойових дій. Аналіз характеристик серцевого ритму в осіб із «гіперчутливістю» і «гіпочутливістю» до дії чинників бойового середовища показав: вищий адаптаційний потенціал мають представники групи «гіпочутливих» військовослужбовців. Розробили модель підтримки ухвалення рішення щодо індивідуального оцінювання адаптаційного потенціалу військовослужбовця за параметрами його чутливості до дії чинників бойового середовища.

In the current conditions of socio-economic and political processes taking place in Ukraine, there is a growing need for more adaptable, universal and uncertain employees. This one is due to the fact that the capacity of used equipment increases every day, and there are extreme situations in the implementation of professional activities, an intensification of communication interactions, and other factors. As a result, certain individuals have an inadequate reflection on reality, which corresponds to the level of their adaptive potential, of course, this also applies to military personnel. However, the vast majority of the army specialties and in the civilian sector are significantly different from each other, so it is natural that the requirements for employees are also different [7].

Many scientific works of researchers from different countries are focused on the problem of increasing adaptability in the workplace, but it is known that the concept of adaptability is quite difficult to measure, and even more effective to predict [22,25].

A number of scientific papers on predicting the adaptation of military personnel to service show that most of them adapt well, but some people have some difficulties of varying degrees, which can manifest themselves in the form of increased stress and mental disorder [2,6,11,21]. Studies of scientists from the Netherlands have demonstrated that the rate of adaptability in servicemen was higher than that in civilians [20].

Naturally, the service in combat conditions increases the emotional tension of servicemen, and, consequently, affects the level of their adaptation to the working environment. Readiness to service in such extreme conditions, which characterizes the dynamic concentration of internal resources of the soldiers and the stability of their psyche in situations when needed different depth, strength and level of physiological reserves involvement, activation of body functions, reflects on the level of their adaptation to specific occupational conditions [19,29].

Other authors support and expand on these findings. Thus, there is an opinion that the severity of harmful factors largely depends on the characteristics of the extreme situation (its power, duration of action, unpredictability, etc.), as well as the willingness of people to work in difficult conditions due to their individual typological features, occupational and psychological resilience, volitional and physical training [3]. In this case, an individual's psyche implements procedures for the acquisition, accumulation and saturation of certain ideas, imaginings and attitudes that are unique to this person and are determined by the psychophysiological processes in a body, manifested in specific conditions [18]. Also, the most important are the following factors: living conditions: physical, technical, chemical, hydrometeorological (natural), socio-psychological; extreme situations; suddenness and duration of action, as well as the level of conflict, frustration, stress, endurance, agility, anxiety, well-being, activity, mood and motivation, an even greater list of harmful factors that affect the psycho-emotional stress studied in our previous work [14].

At present, it is extremely important to develop the still insufficiently studied issue of assessing the adaptive potential of persons engaged in performing tasks at high-risk conditions. In this sense, the formation of approaches based on the assessment of the perception of conditions and situations that arise in the process of work is relevant.

Aim

The aim of the study is to define the adaptive potential of servicemen participating in warfare based on the formation of their perceptions related to operational environment conditions and characteristics of heart rate variability (HRV).

Materials and methods

70 servicemen – men aged 22–30 years, who served in the combat zone for a long time were examined. Valuable information about the external and internal environment factors influence on the human and its adaptation potential are its perceptions (reflection of individual properties of objects, phenomena of external and internal environment) and perception (visual-figurative reflection of objects and phenomena of reality that are currently acting on the senses). The level of perceptions fixed in researches helps to allocate the basic signs concerning characteristics of external environment with simultaneous elimination of insignificance from all complex of the received data [5,10]. The experience of military mission in "hotspots" confirms that it depends on the intensity of event perception, the level of knowledge, mood, experience and perceptions experienced in the present and past, the expectation and desire to see something in the perceived phenomena [13]. Therefore, the success of occupational adaptation depends on the peculiarities of perception and its compliance with the conditions of occupational activity.

To assess the adaptive reserves of human, it is advisable to use techniques that allow us to analyze the perception of servicemen experienced extreme situations, which are determined by the specific nature of their activities. So, at the beginning of the armed conflict in Eastern Ukraine, a specially designed questionnaire "Questionnaire for evaluation of operational environment factors' influence on combatants" that consisted of two blocks reflected the issue of combat environment and deployment life factors (livelihoods) among servicemen in the operational environment has been developed, tested and used by us earlier [11,14,15]. To construct this questionnaire, the semantic differential technique developed by C. E. Osgood (1957) and improved by C. C. Cogliser (1994), with polar values expressed on a scale from 0 to 100 points (c. u.), was used. The questionnaire included characteristics of complexity, inconsistency, uncertainty and dynamism of the operational environment, difficulties in making decisions in short time and lack of information, the likelihood of imminent danger to their lives and lives of friends, duration of physical and informational discomfort, domestic inconvenience and others.

The evaluation of combatants' perceptions on the impact of these factors has been studied retrospectively after of being assigned to military units outside the combat zone.

The study of the autonomic nervous system was carried out according to "international standards" analysis of HRV (Heart Rate Variability, 1996 [28]) for two minutes in the first standard lead. The psychophysiological characteristics were recorded using a special hardware and software system "MPFY Rhythmograph 1" elaborated at the Kharkov National University of Radioelectronics [16,17]. The system was designed to monitor the heart rhythm from the ECG signals in the first standard lead with time and spectral statistical analysis of heart rate. The HRV study was performed on the basis of the military unit at the same time of day – from 9 to 14 o'clock in comfortable conditions (specially equipped room at an air temperature of 20–22 °C, with maximum elimination of all irritants: telephone, other persons, etc.) in a sitting position.

The following characteristics of HRV data were investigated in this research:

1. Statistical parameters – (mode of RR – intervals (mRR, ms), standard deviation of RR – intervals (SDNN, ms), Baevsky stress index (SI $\%/s^2$), mode amplitude (AMo, %), Mode – the value of the most common cardio interval RR (ms), BetaT – symmetry of the T wave of the PQRST cardiocomplex, HR – heart rate (beats/min.);

2. Parameters of HR spectral analysis – total spectral power (TP) in the range 0.003–0.4 Hz characterizes the overall absolute level of human regulatory system activity; VLF – spectral power in the very low frequency range 0.015–0.04 Hz – relative assessment of sympathetic regulation of activity level; LF – spectral power in the low frequency range of 0.04–0.15 Hz – relative assessment of the vasomotor center activity; HF – spectral power in the high-frequency range 0.15–0.4 Hz – relative assessment of the parasympathetic regulation of activity level (respiratory waves), pNN50 – an indicator of the degree of the parasympathetic nervous system predominance over the sympathetic (relative value) (%); W – the width of the scatterogram (ms); CC0 – the degree of the central control circuit activity; VRI – vegetative rhythm index ($1/s^2$).

All examinations were performed in accordance with ethical standards of the responsible committee and the Helsinki Declaration and were approved by the Bioethics Commission of Ukrainian military medical academy.

Statistical analysis of the data was performed using the methods of parametric (Student's t-test) and non-parametric statistics (Wilcoxon's T-test), cluster analysis (*k*-means) for categorization of studied group, step-by-step multiple correlation and step-by-step discriminant analysis [12] using software package Statistica 13.3 (license No. AXA905I924220FAAC).

Results

In modern conditions of constant instability of the operational environment, which is especially evident in the area of hostilities, it is important to obtain additional information about the transformations in the serviceman organism, which are formed in the process of service. One of the most valuable sources of information about these transformations are servicemen perceptions on the conditions of their occupational activities. The imprint left by these perceptions is stored in human memory for more or less a long time, in some way reflects the objective reality and is the material for the formation on the psychological level of its behavioral reactions, and on the psychophysiological – functional state of the human body systems, especially cardiovascular system. This imprint of emotional experiences affects the level of adaptation of a serviceman to the conditions of the existing working environment and can be used to identify mechanisms for its adaptation to the operational environment.

It was shown earlier that the perceptions of environmental factors differ significantly in the surveyed group of servicemen [11,15,25], dividing them into "hypersusceptible" and "hyposusceptible" groups. Therefore, using cluster analysis (*k*-means), the studied contingent was divided into two groups based on the use of their perceptions of the operational environment factors. Additionally, based on the use of the perceptions of servicemen about the effects of life being on them – so called deployment life factor, the studied contingent was divided into two groups. According to the obtained groups, statistical indicators of combat factor or deployment life factor perceptions are presented in *Table 1* and *Table 2*. The size of the groups according to categorization factors (perceptions) was not equal. In categorization by combat factors of warfare, the vast majority (60 %) conditionally (by most indicators) "hyposusceptible" persons were observed, at the same time, these persons became less (48.6 %) in categorization by deployment life factors. That is why these groups were not equivalent.

The distribution of combat factors was based on several scales, the levels of which were radically different ($P < 0.001$): "artillery shelling", "sniper shelling" and "friend wounding". Another group of scales distinguished their average scores at $P < 0.05$. These scales were: "Fear of direct contact with enemy infantry in defense", "Constant expectation of possible direct contact with the enemy while performing tasks", "Fear of injury", "Fear of disability (as a result of injury)" and "Concern about the consequences of personal mistakes (fear of making a mistake, own incompetence)". As can be seen from this list, the vast majority of combatants (60 %) were most affected by the results of the certain weapon use and the consequences of injuring a friend. Less polar were the factors of damage to personal health and life, as well as factors of certain situations of deployment. Perceptions were not at all different in such: "Hail volley fire", "Hurricane", etc., "Mortar shelling", "Tank shelling", «Fear of direct contact with enemy infantry in the offensive", "Fear of stepping on a mine (stretching)", "Fear of hitting a landmine", "Fear of being captured", "Uncertainty in the forecasts of commanders", "Unpredictability of the real situation", "Incompetence of commanders", the consequences of which were unalterable and very bad. One might think that the effect of these factors was so strong that the impressions of their influence became saturated and therefore did not differ significantly from each other in different groups of servicemen.

The distribution of perceptions related to the influence of operating environment factors based on the criteria of life factors gave a slightly different picture (*Table 1*). First of all, in this case, the size of groups was approximately equal. Secondly, groups became noticeable on scales' complex

Table 1. The value of combat factors' perceptions among surveyed servicemen in operational environment in its categorization by the criteria of combat factors and deployment life factors, c. u.

Characteristics	Categorization by combat factors		Categorization by deployment life factors	
	Gr_c1 (n = 28) "Hypersusceptible"	Gr_c2 (n = 42) "Hyposusceptible"	Gr_d1 (n = 34) "Hypersusceptible"	Gr_d2 (n = 36) "Hyposusceptible"
Reactive system volley fire "Hail", "Hurricane", etc.	29.4 ± 4.0	21.4 ± 3.5	28.8 ± 4.1	20.7 ± 3.4
Mortar shelling	19.1 ± 3.3	23.1 ± 3.5	28.4 ± 4.0^^	15.0 ± 2.7
Shelling from a tank	20.9 ± 3.7	19.2 ± 2.9	26.8 ± 3.8^^	13.3 ± 2.1
Artillery shelling	36.2 ± 4.0***	17.8 ± 2.6	28.2 ± 3.6	22.3 ± 3.3
Sniper shelling	47.8 ± 4.7***	26.8 ± 3.1	37.0 ± 4.4	33.4 ± 3.9
Fear of direct contact with enemy infantry in the offensive	30.7 ± 4.4	21.6 ± 3.2	32.4 ± 4.2^^	18.5 ± 2.8
Fear of direct contact with enemy infantry in defense	37.2 ± 3.9*	24.6 ± 3.1	33.3 ± 4.0	26.2 ± 3.1
Constant expectation of possible direct contact with the enemy when performing tasks	39.7 ± 3.6*	26.5 ± 3.4	37.5 ± 3.9^	26.3 ± 3.2
Friend wounding	44.4 ± 4.2***	24.9 ± 3.3	33.0 ± 4.0	32.5 ± 4.0
Death of a friend-in-arms	38.9 ± 4.1*	25.0 ± 3.3	29.8 ± 3.6	31.2 ± 4.0
Fear of injury	35.9 ± 3.8*	23.9 ± 3.2	36.0 ± 4.0 ^^	21.8 ± 2.7
Fear of disability (as a result of injury)	42.9 ± 4.5*	30.8 ± 3.3	41.7 ± 3.5^	29.9 ± 4.0
Fear of stepping on a mine (stretching)	34.1 ± 4.8	26.8 ± 4.1	30.9 ± 4.3	28.6 ± 4.6
Fear of hitting a landmine	41.5 ± 6.4	29.0 ± 4.1	32.2 ± 4.1	35.7 ± 5.9
Fear of being taken as prisoner	30.1 ± 5.5	21.2 ± 3.3	35.1 ± 4.7^^^	14.9 ± 2.9
Uncertainty in the forecasts of commanders, unpredictability of the real development of the situation	25.4 ± 5.2	17.2 ± 3.1	27.1 ± 4.7^	14.2 ± 2.8
Incompetence of commanders	21.4 ± 3.6	13.5 ± 2.6	21.4 ± 3.4^	12.2 ± 2.5
Lack of combat training, fighting spirit of friends	49.4 ± 6.3*	32.1 ± 4.3	38.8 ± 4.8	39.2 ± 5.8
Concern about the consequences of personal mistakes (fear of making a mistake, own incompetence)	41.5 ± 5.0*	26.7 ± 3.6	42.5 ± 4.4^^	23.3 ± 3.7

Grc1, Grc2, Grd1, Grd2: are groups 1 and 2 which were divided according to combat factor characteristics (c) or deployment life factor characteristics (d); ***, ***:** the significant difference of mean data between Group 1_c (Gr_c1) and Group 2_c (Gr_c2) in the parameters of combat factors according to Student's t-test, levels of P < 0.05 and P < 0.001 respectively; **^, ^^, ^^^:** the significant difference of mean data between Group 1_d (Gr_d1) and Group 2_d (Gr_d2) in the parameters of deployment life factors according to the Student's t-test, levels of P < 0.05, P < 0.01 and P < 0.001, respectively.

that was completely different than it was in the first case. This led to the opinion that the perceptions unity using different classification criteria based on one set of scales (combat factors) was not observed. Thus, different criteria covered different areas of perceptions formation. The most striking perceptions in this case were: emotions caused by "Fear of being taken as prisoner" (P < 0.001). Less noticeable were the following perceptions: "Mortar shelling", "Tank shelling", "Fear of direct contact with enemy infantry in the offensive", "Fear of injury", "Concern about the consequences of personal mistakes (fear of making a mistake, own incompetence)" with a significance of P < 0.01.

Even less significant (P < 0.05) was the difference in indicators: "Constant expectation of possible direct contact with the enemy when performing tasks", "Fear of disability (as a result of injury)", "Uncertainty in the forecasts of commanders, unpredictability of the real development of the situation", "Incompetence of commanders". Statistically, such perceptions did not differ: "Hail volley fire", "Hurricane", etc., "Fear of direct contact with the enemy infantry in defense", "Friend wounding", "Fear of stepping on a mine (stretching)", "Fear of hitting a landmine", "Lack of combat training, fighting spirit of friends". The lack of agreement on most indicators (5 out of 8) of the last list with the previous one (according to the criteria of combat factors) indicated that the "saturation" of servicemen perceptions divided by deployment life factor indexes was different than when dividing servicemen by combat factors.

A completely different structure among servicemen was observed in terms of deployment life factors (*Table 2*). In this case, the difference in combat factors was observed in only one indicator that caused the arrangement of this contingent into two groups with a significance of P < 0.05: "Comfort of stay in the team (at home)". This confirmed the poor distinction of combat factor criteria in terms of their impact on the perception's formation on deployment life factors.

On the other hand, the differentiation by the characteristics of deployment life factors made it possible to obtain a reliable result on the vast majority classification of characteristics, except for one indicator – "Comfort of stay in the team (at combat)", which was statistically different in all groups. The later result illustrated the fact that surveyed military personnel during deployment period in combat zone had no problems with joint cooperation in combat conditions. In addition, it should be noted that the differentiation according to the characteristics of deployment life factors was weightier than to the characteristics of combat factors. This thesis was confirmed by more undeviating differentiation of surveyed servicemen perceptions when we used combat factors (10 out of 19 in both cases) and exceptionally large discrepancy in the differentiation of surveyed persons by deployment life factors (19 out of 20 in the case of deployment life factors and 1 out of 20 in the case of characteristics of combat factors).

Thus, it is worth noting that the most significant differential ability had the characteristics of the deployment life factor than the combat factors. This indisputable fact can be confirmed once again by comparing the profiles of the perception expression in the respective groups 1 and 2 when applying the non-parametric Wilcoxon T-test (*Table 3*).

If we totally analyze the developed profiles of perception related to the combat factors and deployment life factors, which were obtained by dividing into groups, we can consider them in terms of the concept of "confidence".

Table 2. The value of deployment life factors' perceptions among surveyed servicemen in operational environment in its categorization by the criteria of combat factors and deployment life factors, c. u.

Characteristics	Categorization by combat factors		Categorization by deployment life factors	
	Gr_c1 (n = 28) "Hypersusceptible"	Gr_c2 (n = 42) "Hyposusceptible"	Gr_d1 (n = 28) "Hypersusceptible"	Gr_d2 (n = 42) "Hyposusceptible"
Accommodation in a dugout	33.8 ± 4.3	23.6 ± 3.2	35.3 ± 3.8	20.5 ± 3.2^^
Accommodation in a tent	54.8 ± 4.5	60.2 ± 3.9	68.0 ± 3.5	48.7 ± 4.1^^^
Living in destroyed buildings	50.7 ± 4.9	47.5 ± 3.8	57.2 ± 4.1	40.8 ± 3.9^^
Malnutrition (due to irrational and inconsistent nutrition)	40.8 ± 4.9	45.0 ± 3.2	52.8 ± 4.1	34.3 ± 3.0^^^
Prolonged stay in low temperatures	49.7 ± 4.3	53.8 ± 3.2	65.4 ± 2.9	39.6 ± 3.0^^^
Prolonged stay in hot conditions	36.3 ± 5.2	42.6 ± 3.8	51.7 ± 4.3	29.0 ± 3.6^^^
High humidity, precipitation	34.4 ± 4.7	35.8 ± 3.3	50.1 ± 3.2	21.2 ± 2.8^^^
Staying in mud underfoot	26.7 ± 4.1	33.1 ± 3.5	41.9 ± 3.9	19.8 ± 2.7^^^
Lack of possibility of regular washing	41.8 ± 4.9	31.7 ± 3.7	43.7 ± 4.0	28.2 ± 4.1^^
Lack of opportunity to always wear clean clothes	51.1 ± 5.5	52.5 ± 4.1	62.3 ± 3.8	42.1 ± 4.8^^
Disorders of habitual sleep (duration, continuity)	70.4 ± 5.1	61.3 ± 4.7	76.2 ± 3.9	54.3 ± 5.2^^
Lack of equipment	45.7 ± 3.9	36.1 ± 3.5	47.8 ± 4.2	32.5 ± 2.9^^
Comfort of stay in the team (at combat)	64.6 ± 5.4	98.0 ± 22.8	75.2 ± 3.2	93.7 ± 27.0
Comfort of stay in the team (at home)	64.1 ± 4.5 *	50.5 ± 3.7	62.0 ± 3.5	50.2 ± 4.5^
Frequent conflicts with commanders	59.2 ± 4.9	55.7 ± 3.9	67.5 ± 2.8	47.2 ± 4.7^^^
Conflict situations with colleagues	71.2 ± 4.9	57.9 ± 4.6	76.6 ± 2.9	50.5 ± 5.3^^^
Social isolation: inaccessibility to the media (TV, Internet, press), etc.	36.2 ± 5.1	39.5 ± 3.8	53.2 ± 4.3	24.0 ± 2.6^^^
Remoteness and anxiety about family	36.7 ± 6.0	40.6 ± 4.2	56.2 ± 5.0	22.8 ± 3.0^^^
Quality of medical care (lack of individual first aid kits, etc.)	27.2 ± 5.3	38.3 ± 3.6	43.8 ± 4.4	24.5 ± 3.7^^
Long monotonous work	40.2 ± 4.8	43.4 ± 4.5	59.7 ± 4.1	25.5 ± 3.2^^^

Grc1, Grc2, Grd1, Grd2: are groups 1 and 2 which were divided according to combat factor characteristics (c) or deployment life factor characteristics (d); ***, ***:** the significant difference of mean data between Group 1_c (Gr_c1) and Group 2_c (Gr_c2) in the parameters of combat factors according to Student's t-test, levels of $P < 0.05$ and $P < 0.001$ respectively; **^, ^^, ^^^:** the significant difference of mean data between Group 1_d (Gr_d1) and Group 2_d (Gr_d2) in the parameters of deployment life factors according to the Student's t-test, levels of $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively.

Table 3. Medians of perception profiles of combat and deployment life factors, c. u.

Differentiation by characteristics of factors	Profiles of factor susceptibility			
	Combat factors		Deployment life factors	
	Gr_c1 "Hypersusceptible"	Gr_c2 "Hyposusceptible"	Gr_d1 "Hypersusceptible"	Gr_d2 "Hyposusceptible"
Battle	36.2 [20.9–47.8]***	24.6 [17.2–30.8]	43.7 [30.5–67.5]	44.2 [32.4–60.7]
Life	32.4 [26.8–41.7]***	23.3 [13.3–35.7]	56.7 [42.8–75.7]***	33.4 [20.8–52.4]

Wilcoxon T-test corresponds to the $P < 0.001$ level; **Grc1, Grc2, Grd1, Grd2:** are groups 1 and 2 divided according to combat factor characteristics (c) or deployment life factor characteristics (d); **in square brackets** – percentile range 10–90 % of data.

This concept is usually considered to be derived from the situationally generalized experience of the subject. This experience is a significant factor in the reception and processing of information on an unconscious level, as well as for decision-making process, which is interpreted as an individual experience of alternatives' significance balance with available evidence and time to choose any of them [26].

Considering the obtained data, it could be conditionally declared that a person who perceives harmful operational environment factors evaluates them with more or less high confidence in ranges of 0–44 % and 56–100 %, i. e. when the opinion about the effect of the factor is accurately low or high. An estimate in the range of 45–55 % may indicate less confidence in the quality of the studied factor. If we consider the formulated opinion, then considerable confidence in making the appropriate decision is observed in differentiations of groups 1 and 2 based on the deployment life factors for several reasons. At first, the profiles of groups 1 and 2 according to these characteristics differed with high significance. Secondly, the differentiation according to the characteristic of deployment life factors was more noticeable than according to the combat conditions, indicating a greater confidence of servicemen in deciding on the action of operational environment factors. Such considerations can serve as a basis for recognizing such deployment life factors as more adequate to solve the problem. If we accept this statement, it can be noted that in this case group 1 had greater values of median profiles than group 2. In other words, the differentiation of the studied contingent into groups of "hypersusceptible" and "hyposusceptible" to harmful operational environment factors was more noticeable when applying criteria of deployment life factors. Probably, certain criteria were more natural because when they were used, there were no factors that directly affected the lives and safety of combatants. Therefore, when assessing operational environment factors, their perceptions are not very polar and contradictory. Thus, the most reliable conclusions about the action of operational environment factors can be obtained by the criteria of deployment life factors, which allows us to consider these criteria the most susceptible to the effects of harmful operational environment factors among combatants.

To further analyze the differences in adaptation potential of combatants "hypersusceptible" and "hyposusceptible" to harmful operational environment factors, a technique to determine the correlations between the adaptability of servicemen and their heart rate regulation using stepwise multiple regression analysis was used. The results of the analysis are presented in *Fig. 1*. The beta regression coefficients show a part which can change the average value of the dependent variable when changing the value of independent at constant level of values of other independent variables. In other words, this coefficient allows to define the relative contribution of the corresponding independent variable to the dependent variable [12].

First of all, it should be noted that the value of the multiple correlation coefficient for group 1 was R = 0.61 ($P < 0.007$), and for group 2 – R = 0.83 ($P < 0.00009$) indicating the presence of stronger link between the level of adaptability and the parameters of heart rate regulation among “hyposusceptible” servicemen.

The analysis of obtained data allowed formulation of several requirements detailing the interpretation of the adaptive capabilities of “hypersusceptible” (Group 1) and “hyposusceptible” (Group 2) servicemen. First, there was a closer relationship between adaptability and heart rate parameters in the group of “hyposusceptible” servicemen that may indicate a greater susceptibility to random abnormalities in the external and internal environment on the human body due to the rigidity of its regulatory systems. Second, the connection of a large number of human regulatory capabilities, which was reflected in the greater number of HRV parameters covered by the regression model, indicated a plurality of channels influencing the functional state of the body to ensure its ability for adaptation to changes in external and internal environment. Increasing the number of interacting regulatory systems led to increased inertia, slow adaptation processes in the body due to the need for coordination of a larger number of activity parameters. Third, the presence of both regression model characteristic (groups of “hypersusceptible” and “hyposusceptible”) might prove a certain coincidence of adaptation mechanisms in the surveyed groups of servicemen. Fourth, the most important in ensuring the adaptability of “hyposusceptible” servicemen (according to the largest values of regression coefficients) were the HF and SI parameters, which represented mainly the strength of the parasympathetic heart rate regulation and the degree of predominance of heart rate regulators.

Confirmation of formulated thesis were the data received from estimation of heart rate spectral analysis, presented in *Fig. 2*.

First of all, it is worth mentioning that all HRV values in both surveyed groups differed significantly: the LFnorm index with a significance of $P < 0.05$; HFnorm with a significance of $P < 0.05$; by LF/HF with a significance of $P < 0.01$. These data showed that the group of “hypersusceptible” servicemen had higher values of LF/HF, indicating a violation of the spasmodic balance, higher physiological cost of living and lower potential for adaptation in this group.

As a result of the heart rhythm analysis among people with “hypersusceptibility” and “hyposusceptibility” to the action of combat factors, it was found that representatives of the “hyposusceptible” servicemen group had a higher potential for adaptation.

For the practical use of the obtained results using step-by-step discriminant analysis, the decisive rules that allow to determine the level of adaptive potential of the serviceman by assessing the effects of combat and deployment life factors have been developed.

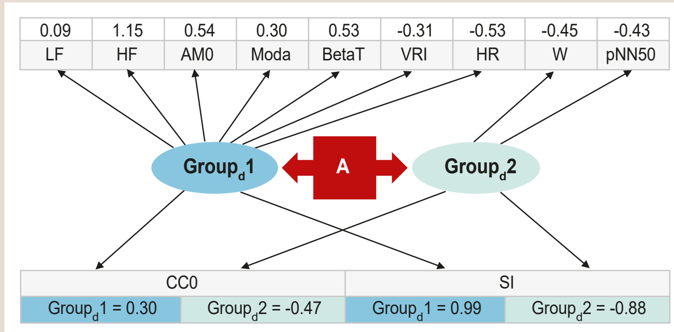

Fig. 1. Correlation between the adaptability indicator of servicemen (A) and indicators of their heart rate variability.

LF: power spectrum of the low-frequency component of HRV (ms^2); **HF:** power spectrum of the high-frequency component of HRV (ms^2); **AM0:** the number of cardio intervals corresponding to the values of mode, as a percentage of the sample size (%); **Mode:** the value of the most common cardio interval RR (ms); **BetaT:** symmetry of the T wave of the PQRST cardiocomplex; **SI:** stress index of the heart regulatory systems (%/s^2); **HR:** heart rate (beats/min.); **pNN50:** an indicator of the degree of predominance of the parasympathetic nervous system over the sympathetic (relative value) (%); **W:** the width of the scatterogram (ms); **CC0:** the degree of the central control circuit activity; **VRI:** vegetative rhythm index (1/s^2).

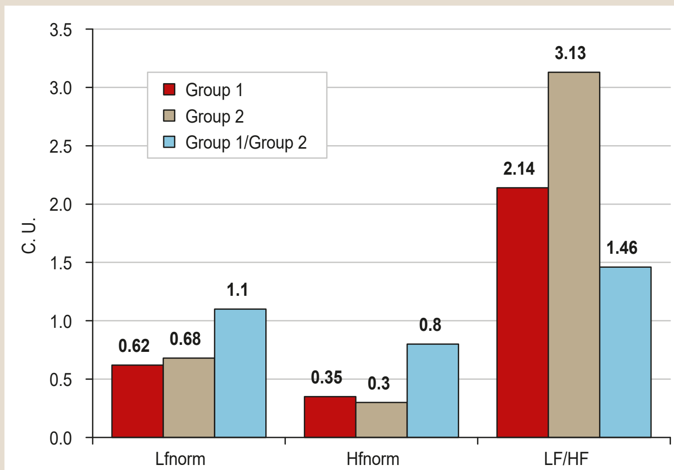

Fig. 2. Heart rate spectral characteristics of the “hypersusceptible” (Group P 1) and “hyposusceptible” (Group 2) to the effects of harmful operational environmental factors of servicemen.

LFnorm: normalized power of the low-frequency domain of the HRV spectrum; **HFnorm:** normalized power of the high-frequency domain of the HRV spectrum; **LF/HF:** a measure of sympathetic balance; **on the abscissa:** studied indicators of HRV; **on the ordinate:** levels of indicators, c. u.

After assessing the impact of the factors in operational environment, it was necessary to make appropriate calculations according to the following rules to support the decision for defining the adaptation capacity level:

$$\begin{cases} VA = -8.037 + 0.049 \times X1 + 0.218 \times X2 + 0.049 \times X3 + \\ + 0.022 \times X4 - 0.045 \times X5 + 0.105 \times X6 - 0.080 \times X7 + \\ + 0.068 \times X8 + 0.007 \times X9 + 0.007 \times X10 - 0.018 \times X11 \\ + 0.045 \times X12 + 0.044 \times X13 + 0.001 \times X14; \\ \\ NA = -25.389 - 0.114 \times X1 + 0.418 \times X2 + 0.064 \times X3 + \\ + 0.122 \times X4 - 0.117 \times X5 + 0.174 \times X6 - 0.119 \times X7 + \\ + 0.101 \times X8 - 0.046 \times X9 + 0.068 \times X10 - 0.050 \times X11 - \\ - 0.011 \times X12 - 0.028 \times X13 + 0.064 \times X14; \end{cases}$$

where X1 – high humidity, precipitation; X2 – long stay in low temperatures; X3 – social isolation: inaccessibility to the media (TV, Internet, press), etc.; X4 – long monotonous work; X5 – living in destroyed buildings; X6 – artillery shelling; X7 – rocket-propelled grenade fire “Hail”, “Hurricane”, etc.; X8 – no possibility of regular washing; X9 – fear of stepping on a mine (stretching); X10 – remoteness and anxiety about family; X11 – fear of direct contact with enemy infantry in the offensive; X12 – quality of medical care (lack of individual first aid kits, etc.); X13 – wounding friends; X14 – fear of injury.

The result of estimating the level of adaptive potential could be obtained after comparing the results of solution to both equations. If NA ≥ VA, it was necessary to make a conclusion about low adaptive potential or if the contrary – the high adaptive potential.

The application of obtained equations allowed to estimate the value of the adaptive potential to the action of harmful operational environmental factors with an accuracy of 98.6 %.

Discussion

The influence of combat experience on psychologically healthy soldiers’ attentiveness to environmental threats was studied by B. Ranes et al. in 2017 [23]. In this study, the authors examined one such change that could occur in otherwise psychologically healthy soldiers: how prolonged or intense experiences with war-related stressors can increase the proclivity of individuals to exhibit threat-attention biases. However, this study did not assess whether participants with more combat experience exhibited a psychologically healthy (or unhealthy) level of attention to environmental threats.

Fani N. et al. [9] reported that during a dot-probe task, individuals who exhibited threat-attention biases demonstrated exaggerated startle responses when shown both threatening and neutral perceptions. Individuals who exhibited threat-attentional biases often had to manage significant psychological and physiological challenges [1,8]. Because individuals with threat-attention biases had difficulty shifting their attention away from perceived threats, they expended excessive cognitive resources in monitoring the real and potential threats that they perceive in their environments [1]. They also tended to use significant physical resources for regulating their often strong and negative behavioral reactions to stimuli they perceived as threatening [8].

The point of view of many scientists on the need for a systematic approach to deepen research processes of operational environment, in particular – human behavior as a subject and its physiological support, becomes clear from the above. According to R. Briner and Dr. G. Balamurugan, the level of stress at the work place can be indicated by threatening or aggravating situations that manifest themselves in difficult operating conditions [4]. Its development is facilitated by the following provoking factors: high workload, high duration, tense interpersonal relationships in the team and others. The human response is the formation of appropriate physical, psychological and behavioral symptoms [24].

Most of these studies characterize various aspects of the impact of the operating environment on the functional (psychological) state of people, as well as the development of PTSD. However, an important aspect of the study is the combination of psychological reflection of reality with the physiological cost of adaptation, studied, for example, by the parameters of HRV.

That is why the fact of the harmony of subjective perceptions and the functional state of the person being evaluated objectively was noted by us earlier [15,27]. Its practical use became relevant in conditions where it was difficult to conduct detailed physiological studies. In healthy, adapted people, the predominance of parasympathetic effects on heart rate has been noted by many authors [19]. This study has shown the results of multiple regression analysis in the group of “hyposusceptible” servicemen (group 2) on certain parameters of interaction between adaptability and heart rate characteristics, demonstrating less adaptive potential compared to the group of “hypersusceptible” servicemen. Therefore, an attempt made by individual use of subjective assessments to determine the adaptive potential of combatants can be considered useful for practical application in the combat zone.

Thus, as a result of the study, significant sensitivity and informativeness of assessments of the harmful deployment life factor impact on servicemen in the combat zone have been shown. On this basis, it has been proved that the adaptive potential of servicemen who were “hyposusceptible” to the influence of these factors was higher than that in “hypersusceptible”. The established fact allowed to develop a model for support the decision-making assessment of servicemen adaptive potential according to the parameters of their susceptibility to combat factors.

Conclusions

1. Among the operational environment factors, the most significant were the deployment factors, which has allowed us to consider these characteristics as the most susceptible to harmful operational environment factors in combatants.

2. The analysis of the heart rate variability characteristics of servicemen with “hypersusceptibility” and “hyposusceptibility” to the operational environment factors has shown higher adaptive potential in representatives of “hyposusceptible” servicemen group.

3. The decision support model for individual assessment of the adaptive potential in servicemen according to the parameters of their perceptions of the operational environment factors (combat and deployment life factors) has been developed.

Perspectives for further research. It is planned to study the adaptive potential as a complex hierarchical-parity system of interaction between environmental factors with psychophysiological features of human: ontogenetic (individual-typological), personal (emotional, physical, volitional, self-actualization potentials), psychodynamic features of central nervous system in modeling contradictory information as well as the factor of its uncertainty.

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