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Original Article

The effect of stress factors on cognitive and management functions of cadets of higher military educational institutions

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Abstract:
The article describes the characteristics of stress factors influence on the cognitive and managerial functions of senior year cadets of the National Defense University of Ukraine named after Ivan Chernyakhovsky. Intensive (submaximal) physical exertion (a 5 km forced march carrying all equipment and clothing) at high ambient temperature (+29 ºC) and humidity (61%) were considered as stress factors. *Aim of the study*: to determine the effect of long-term intensive physical activity in high ambient temperature on the intelligent and managerial abilities of cadets. *To obtain factual data*, *we used the following research methods*: non-invasive instrumental methods, sociological methods (surveying), and mathematical statistics. *Results of the study*. The descriptive statistics for the studied indicators included the median (Me), and the 25th and 75th percentiles. The changes in the functional state of the cardiovascular system of military servicemen induced by high-intense physical exertion in the heat were identified. During the 5 km forced march the heart rate was in the range from 162 to 181 bpm (the submaximal intensity level) during 22.14 min.s and above 181 bpm (the maximum intensity level) during 4.55 min.s The minimum and maximum heart rate of servicemen during running in high ambient temperature was 83 bpm and 210 bpm. The analysis of the running pace over the 5km distance indicated a decrease with each subsequent kilometer; the performance decreased on average by 20-25 s, which indicated low endurance and increasing fatigue. The cognitive and managerial functions of the cadets were assessed under the conditions of stress and fatigue. It was found that only 7.7% (n=2) of subjects had maximum short-term memory span scores, 34.6% (n=9) had high attention concentration scores, and 34.6% (n=9) had high scores for attention span and attention switching. The correlation analysis demonstrated that the time for completing the 5 km distance negatively affected the cognitive and managerial functions of the cadets. This indicator was negatively correlated with the short-term memory span, concentration of attention, division and switching of attention, the number of mistakes made during the tests, and self-efficacy: the correlation coefficients (r) were in the range from -0.623 to -0.862 at $p<0.001$. Work with maximum intensity during the forced march had a negative effect on cognitive functions. In particular, the correlations ranging from $r=-0.467$ at $p<0.05$ to $r=-0.764$ at $p<0.001$ indicated that it was difficult for servicemen to concentrate and to perform intelligence test tasks efficiently.
Conclusion. Successful performance of professional tasks under stressful conditions depends on the level of physical working capacity and stability of higher nervous activity of military personnel. The target-oriented development of aerobic endurance in servicemen is necessary for the effective performance of intelligence test tasks that assess the memory, attention, thinking, perception, and processing of information during high-intensity physical activities in high ambient temperatures.
Keywords: servicemen, high intensity physical activity, extreme conditions, high ambient temperature.

Introduction.

Literature analysis indicates that there are a significant number of publications related to functional processes in the human body under high ambient temperature conditions. In their studies, Bahr and Reeser indicate that physiological responses to weather and climate conditions are individual. Even highly conditioned athletes can experience functional impairments of varying severity when exposed to high ambient temperatures (Armstrong et al., 2007; Jinna, Adams, 2013; Bergeron, 2015; Brocherie, 2015). With long-term exposure to high ambient temperature, athletes can experience heat cramps in the legs and arms during intense and long-term physical activities; this is especially true for middle- and long-distance runners, football and rugby players (Mountjoy et al., 2012; Nassis et al., 2015). During heat stress, the changes occur in the function of the central nervous system that result in impaired coordination of movements, disorientation, and impaired cognitive functions. Physiological adaptive responses of the body to physical exertion under stressful conditions depend on the level of physical working capacity of the individual. In high ambient temperatures, the general condition of the body and physical performance are adversely affected by high relative humidity. The authors of the studies

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involving conditioned athletes (Maughan, Otani, Watson, 2012) note a more significant increase in physiological strain.

There are a number of publications investigating cognitive processes under stressful situations in extreme conditions (Petrachkov et al, 2022; Plisko et al, 2018). Stress factors cause the normal physiological changes in the body. The studies by Ilyin (2003) have scientifically proved that a relatively low level of stress results in increased attention and thinking abilities of the subjects. This is probably due to the intensified functions that related not only to information perception and processing, but also to subconscious thinking processes (Pavlov, 2007; Korobeynikov et al., 2017). The long-term exposure to high ambient temperatures leads to a significantly impaired sensorimotor responses. Operational thinking and operational memory are most influenced under conditions of mental stress caused by high ambient temperatures (Horn, 2002). It is these cognitive functions that lose stability and mobility and can acquire a rigid nature, which leads to the interruption of performance of the activity. A decrease of attention may be observed in stressful situations. Cognitive and managerial functions are critically important for officers, as they ensure the ability to make decisive and courageous decisions under extreme conditions, when the success of the task performance, one's own life, the life of subordinate servicemen, and the fate of the entire team depend on the decision made (Kostiv et al. 2021; Shostak, 2021). Therefore, the level of development of emotional and volitional qualities, such as the mobilization of physical and mental abilities, patience, endurance, courage, determination, resistance to prolonged stressful activity and exertion during performance of job competencies, serves as a criterion for assessing the managerial competence of future physical education and sports professionals of the Ukrainian Armed Forces (Babaian, Grishman, 2014; Yagupov, Kostiv, 2019). Military personnel of the Armed Forces have to perform their professional duties under various adverse environmental conditions (Afonin, et al. 2010; Anohin, et al. 2022; Petrachkov, 2014; Verbyn, 2015). Furthermore, the intensity of physical activity can be in submaximal and maximal range (Shlyamar, et al. 2015). Modifiers of heat stress negatively influence physical working capacity; however, the professional responsibilities of military personnel remain the same (Petrachkov, 2015; Bykov, Malyarenko, 2016; Yagupov, 2019). Three factors affect the decrease in physical working capacity in elevated ambient temperatures: overheating of the body, rapid dehydration, and a decrease in the blood oxygen-carrying capacity (Petrachkov, 2015). Therefore, it is important for servicemen to have a high anaerobic threshold. During intense physical exercise in high ambient temperatures, a sharp increase in blood lactate levels is observed, since the rate of lactate formation exceeds utilization. It is this factor that negatively affects the cognitive functions of an individual; and the lack of substantiated scientific data determines the relevance of this study.

A comprehensive study of cognitive and managerial functions of cadets of higher military educational institutions under stress conditions has important practical significance for the theory and methodology of physical education and sports. Such studies complement the physiological characteristics of muscle activity under extreme conditions of high ambient temperature and relative humidity. The obtained data allow to establish the degree of influence of intense physical loads on the adaptation capabilities of the cadets' body. The study of changes in the cardiorespiratory function in military personnel under the stress influence provide an opportunity to appropriately influence the structure of the educational and training process.

Materials and methods.

Study participants. The study of the impact of stress factors on cognitive and managerial functions involved 26 cadets with an average age of 19.7 years. The study was conducted at the National Defense University of Ukraine named after Ivan Chernyakhovsky in July 2021. Cadets of the 3rd and 4th years at ambient temperature of +29 °C and relative humidity of 61% ran a 5-km forced march in the uniform No. 4 with a machine gun and a gas mask. Before starting the study, all involved cadets signed an informed consent form.

Organization of the study. Garmin Fenix 6S Pro sports watches were used to monitor physical activity during the 5-kilometer march. We recorded the time for completing the distance (min.s), average pace of running per km (min.s), average cadence (steps per minute), average, minimum, and maximum heart rate over the distance (bpm), basal metabolic rate (kcal), time in the low-intensity zone (heart rate from 101 to 120 bpm), in the moderate-intensity zone (heart rate from 121 to 140 bpm), in the high-intensity (heart rate from 141 to 161 bpm), in the submaximal-intensity zone (heart rate from 162 to 181 bpm), and in the maximum-intensity zone (heart rate above 181 bpm) (min.s).

Immediately after completing the 5-km forced march, cadets performed a set of test tasks that included an assessment of cognitive and managerial abilities. The memory function was assessed using a short-term memory test (Korobeynikov et al., 2013). The number of correctly recalled 12 pairs of two-digit numbers presented to the subject within 30 s was determined. The short-term memory span was measured as a percentage value. The Pieron-Ruser test was used to measure the level of attention concentration. The test is a form depicting four types of geometric shapes, which are placed in 10 rows of 10 shapes. The subject is asked to fill in the appropriate symbols as quickly as possible and without errors in the form with four different shapes in 1 minute: a plus in the square, a minus in the triangle, nothing in the circle, and a dot in the rhombus. The shapes are filled sequentially from left to right, first the top row and then the row below. The test is performed immediately after giving the instruction. The results were scored as follows: 100 points – a very high level of attention concentration; 91-99

points – a high level; 80-90 points – a moderate level; 65-79 points – a low level; and 64 points and less – a very low level. The Schulte table test was used to assess the division and switching of attention. The test form includes two squares. In the upper square, the 5-to-5 grid is filled with 25 randomly selected numbers from 1 to 99. In the lower square, there are 25 free cells. The subject must rewrite the numbers from the upper square to the lower one in ascending order, starting with the smallest number. The subject must fill in the lower square in sequence. It is not allowed to make any marks in the lower square. If the subject missed a number, he writes it in the next free cell and circles it. Two minutes are given to complete the task. It is necessary to arrange the maximum possible number of numbers during this time without mistakes. The test results are checked using the 'key'-form. The number of numbers entered in the lower square of the form (productivity) and the number of mistakes, i.e. missed numbers, are counted (mistakes detected by the subject himself, as well as circled numbers are taken into account). The relative frequency of wrong answers is determined (the ratio of the number of mistakes to the total number of numbers entered). The scoring of the test results was carried out using Table 1. Self-efficacy, i.e. a person's confidence in own capability to organize and perform the actions needed to achieve a specific goal, was measured with the General Self-Efficacy Scale by R. Schwarzer and M. Jerusalem. The self-efficacy scale was scored on 10 items, which the subject was asked to provide responses about the effectiveness of their activity. The responses were scored as follows: not at all true – 1; hardly true – 2; moderately true – 3; and exactly true – 4 points. The final score was a sum score for all 10 items. The obtained scores were interpreted as follows: 36-40 points – high; 30-35 points – higher than average; 25-29 points – average; 20-24 points – lower than average; 19 points or below – low self-efficacy. The cadets who took part in the study provided written voluntary consent to use personal data, as well as for further processing of the obtained data for scientific purposes.

Table 1. Scoring table for the Schulte table test

Indicator	Value									
The number of correctly entered numbers	≥ 23	22	21	20	18-19	16-17	14-15	13	9-12	≤ 8
Score	10	9	8	7	6	5	4	3	2	1

Statistical analysis. Statistical data analysis was carried out using the Statistica 10.0 software package for processing statistical information (StatSoft, Inc., USA). Mathematical statistical analysis was used to prove the regularities discovered in the study, to correctly interpret the obtained results, and to assess the effects of stress factors on the cognitive and managerial functions of the cadets. For a detailed description of the obtained results and taking into account the sample size, the following statistics were used: median (Me), 25th and 75th percentiles, minimum and maximum values, and coefficient of variation (V, %). The non-parametric Spearman's correlation coefficient (r) was used to analyze the structure of relationships between the variables.

Results.

The data presented in terms of medians (Me) showed that the cadets had low speed and running pace over the 5km forced march. The analysis of individual performance in the 5km forced march revealed the cadets whose results were below the 75th percentile and ranged from 37.07 min.s to 42.29 min.s, which corresponds to a low level of endurance (table 2).

Table 2. Performance in the 5km forced march (n=26)

Parameter	Me	25th percentile	75th percentile	Min	Max	V (%)
Time for completing the 5km forced march (min.s)	34.26	32.22	37.07	30.02	42.29	9.8
Average heart rate over the distance (bpm)	177.0	163.0	187.0	144.0	199.0	8.4
Minimum heart rate over the distance (bpm)	110.5	99.0	128.0	83.0	148.0	16.7
Maximum heart rate over the distance (bpm)	194.0	188.0	202.5	172.0	210.0	5.9
Average cadence (steps per min)	150.0	146.0	159.0	132.0	166.0	5.7
Average pace of running (min.s per km)	6.44	6.28	7.08	6.07	7.41	16.6
Basal metabolic rate (kcal)	430.5	401.0	466.5	239.0	537.0	16.6
Duration of low-intensity activity (min.s)	0.33	0.17	0.36	0.03	1.06	73.1
Duration of moderate-intensity activity (min.s)	1.11	0.55	1.40	0.04	2.30	67.8
Duration of high-intensity activity (min.s)	2.25	1.34	8.19	0.11	23.43	107.8
Duration of submaximal-intensity activity (min.s)	22.14	17.21	24.34	4.05	30.34	34.6
Duration of maximum-intensity activity (min.s)	4.55	2.59	4.05	1.18	5.12	99.2

The basal metabolic rate during the forced march was 430.5 kcal with a heart rate of 177.0 bpm. The value of the median (Me), the 25th and 75th percentiles of heart rate (177.0; 163.0; and 187.0 bpm) indicated the submaximal intensity of physical activity. Most of the time, namely 22.14 minutes, the work was performed in the submaximal zone and 4.55 minutes in the maximum zone. It can be concluded that the conditions of high ambient temperature and relative humidity negatively affected the function of the cardiorespiratory system of servicemen. The obtained results indicate the extreme functional strain of the physiological systems that are

responsible for acute adaptation of the body, which is characteristic of the first stage of stress during its transition to the stage of exhaustion. The level of special endurance of servicemen was determined based on the running pace over the 5km forced march (see Figure 1). It should be noted that there was a decrease in the running pace by 18-34 seconds for each subsequent kilometer. The obtained results indicated low cardiorespiratory endurance, which is the most important component of physical fitness. Only 19.2% (n=5) of people had high aerobic capacity, which is an important determinant of the efficient thermoregulatory control in high ambient temperatures and reflects the high exercise tolerance of the cardiorespiratory system under extreme conditions). It is common knowledge that muscular contractions that rely on the anaerobic lactic energy system cannot last for a long time because of a significant amount of byproducts (lactic acid or lactate) accumulated in the blood, which result in acidosis. Significant acidosis and high intensity of glycogen consumption lead to a substantial decrease in the intensity of physical work and negatively affects cognitive functions. Aerobic power and functional capacity of the body are important elements of functional preparedness and characterize the level of development of the most important motor quality, i.e. general endurance. The running protocol for the 5km forced march indicated an early onset of fatigue in cadets. Fatigue is the main factor that prevents optimal muscular activity. Even slight fatigue negatively affects the overall performance: muscle strength decreases, reaction time increases, speed of movement slows down, agility and neuromuscular coordination deteriorate, and the overall speed decreases. Fatigue negatively affects a person's psychophysiological functions. We assessed the cognitive and managerial abilities of cadets under stress. The results indicate a significant impact of fatigue on the main cognitive functions of servicemen (Table 3). In terms of the median (Me) and the 75th percentile, the amount of short-term memory of the cadets was 37.5(41.7)%, which corresponds to the average level, whereas in subjects whose results were below the 25th percentile, a low level was found.

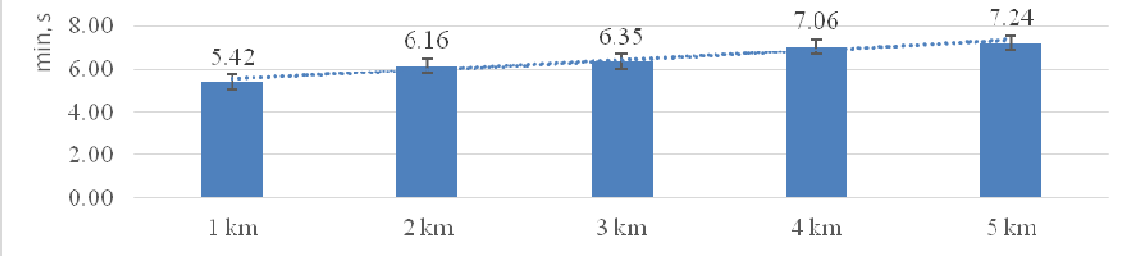

Figure 1. Running pace of the cadets over the 5 km forced march

Among the studied cadets, 7.7% (n=2) of individuals were found to have the maximum span of short-term memory, which indicates high adaptive capacity of the autonomic nervous system to the stress factors. In order to determine the level of attention concentration of servicemen, we used the Pierron-Ruser test. The 'high performance' scores were found to prevail. The median value of the indicator was 81%, which corresponded to the average level. A very low level of attention concentration was observed in 38.5% (n=10) of subjects, their results were in the range from 21 to 60%.

Table 3. Cognitive and managerial abilities of cadets after the completion of the 5 km forced march

Parameter	Me	25th percentile	75th percentile	V (%)
Cognitive abilities				
Short-term memory span (%)	37.5	25.0	41.7	44.7
Attention concentration (%)	81.0	50.0	95.0	35.3
Division and switching of attention (points)	6.5	2.0	10.0	68.8
Number of mistakes made	5.5	2.0	15.0	95.5
Managerial abilities (points)				
I can always manage to solve difficult problems if I try hard enough	4.0	3.5	4.0	23.1
If someone opposes me, I can find the means and ways to get what I want	3.0	3.0	4.0	21.8
It is easy for me to stick to my aims and accomplish my goals	3.0	3.0	3.5	25.7
I am confident that I could deal efficiently with unexpected events	3.0	3.0	3.5	17.2
I am confident that I could deal efficiently with unexpected events	3.0	3.0	4.0	21.6
I can solve most problems if I invest the necessary effort	3.5	3.0	4.0	21.7
I can remain calm when facing difficulties because I can rely on my coping abilities	4.0	3.0	4.0	21.5
When I am confronted with a problem, I can usually find several solutions	3.5	3.0	4.0	21.7
If I am in trouble, I can usually think of a solution	3.0	3.0	4.0	23.2
I can usually handle whatever comes my way	3.0	3.0	4.0	22.4
Total score	33.5	31.0	36.0	16.3

The function of division and switching of attention in servicemen was assessed using the Schulte table test, which had to be completed in a restricted time window. Analysis of the test results revealed that 21.3% (n=6) of cadets failed to complete the task and did not score a single point. This category of subjects was characterized by a lack of concentration and inability to focus on a single task. Low scores for cognitive function may indicate the negative impact of extreme factors that caused fatigue and stress in servicemen. Under conditions of fatigue and stress, this category of persons lost part of the potential that ensures their behavioral activity. On the contrary, 34.6% (n=9) of cadets had the maximum scores of 10 points, which indicated the ability to quickly perceive and efficiently process information. This category of people was characterized by a high level of division and switching of attention even under stress.

Based on the results of the assessment of managerial abilities, individuals were identified who were able to make important decisions and take responsibility even under difficult, stressful conditions. Thus, 26.9% (n=7) cadets scored from 36 to 40 points in the test, which corresponds to the high level of self-efficacy. The vast majority of servicemen, i.e. 73.1% (n=19), had scores from 30 to 35 points, which corresponds to the higher than average level. Analysis of the responses for individual items related to the effectiveness of behaviors allowed us to identify 61.5% (n=16) of cadets who are ready to cope with all difficulties because they rely on their own abilities. Among the cadets, 46.2% (n=12) were able to find a solution even in an apparently hopeless situation, because they rely on their own abilities, and only 3.8% (n=1) of cadets believe that they will not be able to make a decision on their own.

The structure of relationships was identified between the functional indicators of the body, running speed over the forced march distance, and the scores of cognitive and managerial abilities. The analysis of the results indicated the dependencies between the variables that affect the intelligent and managerial activities of servicemen (table 4).

Table 4. Correlations between functional indicators of the body, running speed, exercise intensity, and cognitive and managerial abilities of servicemen (n=26)

Parameter	1	2	3	4	5
Time for completing the 5km forced march (min.s)	**-0.783*** **	**-0.623*** **	**-0.859*** **	**-0.676*** **	**-0.862*** **
Average heart rate over the distance (bpm)	**-0.375***	-0.087	**-0.464***	-0.192	-0.177
Minimum heart rate over the distance (bpm)	**0.435***	-0.189	0.134	-0.132	-0.013
Maximum heart rate over the distance (bpm)	-0.285	**-0.451***	**-0.426***	**-0.459***	**-0.420***
Average cadence (steps per min)	0.206	0.086	0.084	-0.055	-0.35
Average pace of running (min.s per km)	-0.105	0.01	0.132	**-0.492****	**-0.378***
Basal metabolic rate (kcal)	**-0.487****	-0.126	**-0.581****	**-0.592*** **	**-0.522****
Duration of low-intensity activity (min.s)	0.02	0.279	0.185	-0.178	-0.031
Duration of moderate-intensity activity (min.s)	0.123	0.319	-0.146	0.142	-0.089
Duration of high-intensity activity (min.s)	0.198	0.076	0.009	0.051	0.261
Duration of submaximal-intensity activity (min.s)	**-0.576**	-0.012	**-0.454***	**-0.445***	0.013
Duration of maximum-intensity activity (min.s)	**-0.764*** **	**-0.619*** **	**-0.467***	**-0.485****	0.208

Notes: 1 – short-term memory span (%); 2 – concentration of attention (%); 3 – distribution and switching of attention (points); 4 – the number of mistakes; 5 – self-efficacy (the sum of points).

Notes: n=26; r=0.374 at $p<0.05$; r=0.485 at $p<0.01$; r=0.592 at $p<0.001$; * – the correlation coefficient was statistically significant at the $p<0.05$ level; ** – the correlation coefficient was statistically significant at the $p<0.01$ level; *** – the correlation coefficient was statistically significant at the $p<0.001$ level.

The short-term memory span of servicemen under conditions of high ambient temperature and intense physical exertion was directly dependent on the minimum heart rate over the 5 km forced march distance (r=0.435 at $p<0.05$). The short-term memory span showed the highest negative correlation with the time for completing the 5km forced march (r=-0.783 at $p<0.001$). Energy supply of muscular work at submaximal power mainly comes from anaerobic glycolysis, which leads to a significant accumulation of lactic acid in the blood. High intensity muscular work is mainly supplied with energy from aerobic metabolism and partially from anaerobic glycolysis. We found a low and moderate correlations between servicemen short-term memory span and the average heart rate over the distance (r=-0.375 at $p<0.05$), as well as between short-memory span and basal metabolic rate (r=-0.487 at $p<0.01$ A high negative correlation was observed between short-term memory span and duration of submaximal intensity activity (r=-0.576 at $p<0.01$), and between short-term memory span and duration of maximum intensity activity with a heart rate higher than 181 bpm (r=-0.764 at $p<0.001$). A significant contribution to the development of fatigue is made by the impairment of electrochemical coupling during neuromuscular transmission of excitation and changes in the activity of the central nervous system due to the development of protective inhibition along with the impairment of trophic functions of the neural tissue and cerebral blood circulation, changes in the concentration of inorganic phosphate, inosine monophosphate, and accumulation of ammonia in tissues. Concentration of attention of cadets under extreme conditions showed a high negative correlation with the time for completing the 5 km forced march (r=-0.623 at $p<0.001$) and with the duration maximum intensity activity with a heart rate higher than 181 bpm (r=-0.619 at $p<0.001$). A low

correlation was observed with the maximum heart rate over the 5km forced march ($r=-0.451$ at $p<0.05$). Everything points to the complex, multifactorial nature of fatigue that develops during maximal and submaximal exercise. The largest number of correlations was observed for the scores for division and switching of attention and the number of mistakes made in the test. The score for division and switching of attention showed a high negative correlation with the time for completing the 5km forced march ($r=-0.859$ at $p<0.001$) and with the basal metabolic rate ($r=-0.581$ at $p<0.01$). During intense physical activity, accumulation of lactic acid in the muscles and a decrease in pH, as well as an increase in temperature reduce metabolic efficiency. In cadets, division and switching of attention showed low negative correlations with the average heart rate during running ($r=-0.464$ at $p<0.05$), the maximum heart rate over the distance ($r=-0.426$ at $p<0.05$), the duration of submaximal intensity activity ($r=-0.454$ at $p<0.05$), and duration of maximum intensity activity ($r=-0.467$ at $p<0.05$). The dependencies that we revealed with the correlation analysis indicated that the number of mistakes made during the test was negatively affected by: the time for completing the 5km forced march ($r=-0.676$ at $p<0.001$); the maximum heart rate over the distance ($r=-0.492$ at $p<0.05$); average running pace ($r=-0.492$ at $p<0.01$); basal metabolic rate ($r=-0.592$ at $p<0.001$); duration of submaximal intensity activity ($r=-0.445$ at $p<0.05$); and duration of maximum intensity activity ($r=-0.485$ at $p<0.01$). The proper functioning of the vascular system determines the function of a number of other physiological systems, ensures the effective use of the body's energy capacity, contributes to its fast recovery and reaching a qualitatively new level of functional condition. Stress factors also affected the ability to make management decisions. Thus, the self-efficacy score showed a high negative correlation with the time for completing the forced march ($r=-0.862$ at $p<0.001$), low and moderate correlations with the maximum heart rate over the distance ($r=-0.420$ at $p<0.05$), with the average running pace ($r=-0.485$ at $p<0.01$) and with the basal metabolic rate ($r=-0.522$ at $p<0.01$). The main causes of fatigue during prolonged high and moderate intensity physical activity are factors related to a decrease in energy supplied to working muscles, as well as a disruption of electrochemical coupling in working muscles and impaired function of the central nervous system under conditions of significant hyperthermia, dehydration, and loss of water and electrolyte balance.

These peculiarities of the correlations indicated a significant influence of fatigue on making important decisions. Cadets who worked at submaximal and maximum intensity during the forced march did not always want to take the responsibility.

Discussion

The obtained results indicate a significant impact of stress factors on physical condition and cognitive functions of servicemen. Optimizing the functional state of servicemen who perform their professional duties under adverse climatic conditions, especially in high ambient temperatures and under intense physical exertion, is an integral part of the system of ensuring the maximum effectiveness of their activities (Stocker, Leo, 2020). Professional activity of servicemen under extreme conditions is associated with the whole-body physiological strain and increased stress on regulatory mechanisms. The stress on regulatory mechanisms leads to the adaptation of physiological responses and metabolic processes to increased physical exertion under conditions of high ambient temperature. Furthermore, in some cases, changes in body functions can be significant (Andrieieva et al, 2020). Overheating results in the impairment of body functions, which lead to a change in the thermal balance of the body (Petrachkov, 2015; Petrachkov, Kosenko, 2015; Verbyn, 2015; Bykov, Malyarenko, 2016), loss of water and electrolyte balance, and dehydration (Korobeynikov et al, 2017). Under hyperthermia, the functional disorders described above negatively affect the effectiveness of the professional activities of servicemen (Shlyamar et al, 2015).

We have confirmed the results reported by Maughan, Otani, and Watson (2012), which indicate that at elevated ambient temperature of +30.2 °C, the endurance exercise performance of men significantly ($p<0.001$) decreased at relative humidity of 60% and 80 % compared to exercising at relative humidity of 24% and 40%.

The findings of our research give reasons to conclude that intensive physical exercise under conditions of high ambient temperature affects the cognitive and managerial abilities of servicemen. The obtained results make contribution to the data (Korobeynikov et al, 2017; Moseychuk et al, 2018; Korobeynikov et al, 2019) that the level of intelligent activity is determined by the properties of the nervous system, and its development and improvement depends on the way the activity is organized.

Conclusions

The results of the study expand the knowledge about the impact of stress factors on the intellectual and managerial abilities of cadets of higher military educational institutions. The influence of high ambient temperature and relative humidity on the adaptation capabilities of the cadets' body under conditions of intense physical loads was assessed. It was found that the aerobic capacity of the body is an important determinant of successful thermoregulatory control in high ambient temperature, which improves tolerance for physical exercise in servicemen. The scores of servicemen in intelligence tests showed a significant variability. This fact indicates the individual responses of the higher autonomic nervous system under stressful conditions.

A large number of inverse correlations between cognitive functions and stress factors were revealed. Stress factors had a negative impact on managerial decision-making, memory, and concentration. The highest

inverse correlations were found between the time for completing the 5 km cross-country march and self-efficacy, the allocation and switching of attention, short-term memory span, the number of mistakes made, and concentration of attention. It was shown that the maximum physical load has a negative effect on the concentration of attention in the cadets.

The theoretical significance of the study is related to the expansion of knowledge about functional reserves of the body and cognitive functions of military personnel during intensive physical exertion under conditions of high ambient temperature. The practical significance of the obtained results is in the selection of methods and approaches that will be implemented into the training program for future physical education and sports professionals of the Ukrainian Armed Forces to increase the functional capabilities of the body under conditions of elevated temperatures, which will increase the efficiency of professional activities.

Conflict of Interest. All the authors declare to have no conflict of interest.

References

Afonin, V.M., Kizlo, L.M., Popovych, O.I. (2010). Preparation of servicemen to act under unusual environmental conditions : study-methodol. guide. Lviv, ASV, 125 p.

Andrieieva, O., Yarmak, O., Kashuba, V., Drozdovska, S., Gineviciene, V., Blagii, O., & Akimova-Ternovska, M. (2020). Efficiency of a Combined Fitness Program for Improving Physical Condition in Young Women. *Physical Education Theory and Methodology*, 20(4), 195–204. https://doi.org/10.17309/tmfv.2020.4.01

Anohin, Y., Romanchuk, S., Tychyna, I., Lesko, O., Dukh, T., Shlyamar, I., Lototskyi, I. (2022). Comparative analysis of the motivation of the military academy students in different years of study towards their own physical improvement. *Journal of Physical Education and Sport*. 22, 1854–1858. DOI:10.7752/jpes.2022.08233

Armstrong, L.E.; Casa, D.J.; Millard-Stafford, M.; Moran, D.S.; Pyne, S.W.; Roberts, W.O. (2007). American college of sports medicine position stand. Exertional heat illness during training and competition. Med. Sci. Sports Exerc. 39, 556–572.

Babaian, Y.O., Grishman, L.O. (2014). Peculiarities of the psychological readiness of military personnel to act under extreme conditions. *Scientific Bulletin of Mykolaiv National University named after V. O. Sukhomlynskyi*. Series: Psychological Sciences, 2 (13), 17–21.

Bahr, R., Reeser, J., C. (2012) New guidelines are needed to manage heat stress in elite sports – The federation international de volleyball (FIVB) heat stress monitoring programme. *Br. J. Sports Med*. 46, 805–809.

Bergeron, M., F. (2015). (Editorial). Training and competing in the heat in young sports: no sweat? *Br. J. Sports Med*. 49, 837–839.

Brocherie, F., Girard, O., Millet, G., P. (2015). Emerging environmental and weather challenges in outdoor sports. Climate. 3, 492–521.

Bykov, A.T., Malyarenko, T.N. (2016). Sports activity under adverse weather and climatic conditions: risks and protection. *Military medicine*, 1, 52-83.

Horn, T. (2002). Advances in Sport Psychology. *Human Kinetics*, 558 p.

Ilyin, E. P. (2003) Human psychomotor organization. Sanct-Peterburg: Piter. 384 p.

Jinna, S., Adams, B. B. (2013). Ultraviolet radiation and the athlete: Risk, sun safety, and barriers to implementation of protective strategies. *Sports Med*. 43, 531–537.

Korobeynikov, G., Korobeinikova, L., Mytskan, B., Chernozub, A., & Cynarski, W. (2017). Information processing and emotional response in elite athletes. *Journal of Martial Arts Anthropology, 17* (2), 41-50. https://doi.org/10.14589/ido.17.2.5

Korobeynikov, G., Potop, V., Ion, M., Korobeynikova, L., Borisova, O., Tishchenko, V., Yarmak, O., Tolkunova, I., Mospan, M., Smoliar, I. (2019). Psychophysiological state of female handball players with different game roles. *Journal of Physical Education and Sport*, 19 (3), 1698 – 1702. https://doi:10.7752/Jpes.2019.03248

Korobeynikov, G., Prystupa, E., Korobeynikova, L., Briskin, Yu. (2013). Assessment of psychophysiological states in sports: monograph. LSUPC, 312 p.

Kostiv, S., Oderov, A., Klymovych, V., Yagypov V., Romanchuk S., Matveiko O., Baidala V., Lesko O., Ostrovskyi M., Kuprinenko O. (2021). Experimental results of the psychophysical endurance development of military professionals. *Journal of Phys ical Education and Sport,* 21(2), 1076 – 1083, https://doi:10.7752/jpes.2021.s2135

Maughan, R. J., Otani, H., Watson, P. (2012). Influence of relative humidity on prolonged exercise capacity in a warm environment. *Eur. J. Appl. Physiol*, 112 (6), 2312–2321.

Maughan, R.J., Otani, H. & Watson, P. (2012). Influence of relative humidity on prolonged exercise capacity in a warm environment. *Eur J Appl Physiol*, 112, 2313–2321. https://doi.org/10.1007/s00421-011-2206-7

Moseychuk, Y., Vaskan, I., Kljus, O., Moroz, O., Balatska, L., Blagii, O., Yarmak, O. (2018). The relationship between cognitive functions and indicators of physical condition in men aged 21-25 years of age. *Journal of Physical Education and Sport*, 5, 2181 – 2185. https://doi.org/10.7752/jpes.2018.s5329

Mountjoy, M. Alonso, J. M., Bergeron, M.F., Dvorak, J., Miller, S., Migliorini, S., Singh, D. G. (2012) Hyperthermic-related challenges in aquatics, athletics, football, tennis and triathlon. *Br. J. Sports Med*. 46, 800–804

Nassis G. P., Brito J., Dvorak J., et al. (2015). The association of environmental heat stress with performance: analysis of the 2014 FIFA World Cup Brasil. *Br. J. Sports Med*. 49 (18), 609–613.

Pavlov, A.S. (2007). Thermophysiology of muscle work and sports stress. Donetsk. 79 p.

Petrachkov, O., Yarmak, O., Biloshitskiy, V., Andrieieva, O., Mykhaylov, V., Chepurny, V., Malakhova, O. (2022). The influence of morphofunctional condition on the physical fitness level of Ukrainian soldiers. *Journal of Physical Education and Sport*. 22 (9), 2182–2189. https://doi: 10.7752/jpes.2022.09278

Petrachkov, O.V. (2014). Physical training as a factor of accelerated adaptation of servicemen to combat activities in the heat. *Bulletin of the National Defense University of Ukraine*, 6 (43), 135–138.

Petrachkov, O.V. (2015). The influence of high ambient temperature on the physical condition of servicemen. *Military education*, 1(31), 173-179.

Petrachkov, O.V., Kosenko, M.S. (2014). Survival as a necessary element of training military personnel for extreme conditions. Physical training of the personnel of the Armed Forces, other military formations and law enforcement agencies of Ukraine: experience, modernity, problems, and prospects for development: Proceedings of the scient.-method. conf. Kyiv: National Defense University of Ukraine, 347–357.

Plisko V., Doroshenko T., Minenok A., Sikura A., Oleshko V., Griban G., Prontenko K., Bondarenko V. (2018). Informational indicators of functional capacities of the body for teaching cadets from higher military educational institutions power types of sports. *Journal of Physical Education and Sport.* 18(2). 1050–1054. DOI:10.7752/jpes.2018.s2156

Popovych, O.I., Fedak, S.S., Romanchuk, S.V. (2010). Special physical training as a means of adaptation to the stress factors of training and combat activities of military personnel. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 11, 88-91.

Shlyamar, I.L., Yaworsky, A.I., Romanchuk, S.V., Petruk, A.P., Dzyama, V.V., Romaniv, I.V., Vorontsov, A.S. (2015). Characteristics of physical loads endured by military officers of mechanized troops during field maneuvres. *Psychology and medico-biological problems of physical education and sports*, 9, 57–63.

Shostak, R.G. (2021). Science and education a new dimension. Pedagogy and Psychology, IX (96), 54-60.

Stocker, H., Leo, P. (2020). Predicting military specific performance from common fitness tests. *Journal of Physical Education and Sport*, 20 (5), 2454–2459. DOI:10.7752/jpes.2020.05336

Verbyn, N. B. (2015). The influence of physical preparedness of servicemen on personal safety under conditions of survival in extreme situations. Special focus of physical training as a component of personal safety of military personnel. Materials of science and method. conf. 145-149.

Yagupov, V. (2019). Theory and methodology of military pedagogical research. National Defense University of Ukraine named after Ivan Chernyakhoskyi. Retrieved from https://elib.nuou.org.ua/katalog/tmvpdiag.html

Yagupov, V., Kostiv, S. (2019). Diagnosing the development of psychophysical endurance of military officers at the stage of operational and tactical training. Science and Education a New Dimension. *Pedagogy and Psychology*, 207(84), 11-17.