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TÍTULO: Rendimiento académico y capacidad mental de los cadetes que practican deportes durante los estudios.

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RESUMEN: El artículo investiga la influencia de las clases deportivas en el nivel de actividad de estudio y capacidad mental de los cadetes durante el estudio en la institución de educación militar superior (HMEI). 271 cadetes participaron en la investigación. Se formaron un grupo experimental (GC) con cadetes que participaban en deportes (n=63) y un grupo de control (GC) que involucraba a los cadetes que estudiaban de acuerdo con el sistema tradicional de entrenamiento físico (n=208). El rendimiento académico se estimó de acuerdo con los resultados de dominar diferentes disciplinas,

capacidad mental, de acuerdo con la prueba de Burdon-Anfimov. Se determina que los cadetes GC tenían mejores indicadores de rendimiento académico y capacidad mental que los cadetes de GC.

PALABRAS CLAVES: cadetes, rendimiento académico, capacidad mental, actividad de estudio, deporte.

TITLE: Academic performance and mental capacity of cadets engaged in sports during studies.

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ABSTRACT: The article investigates the influence of sports classes on the level of study activity and mental capacity of the cadets during the study at the institution of higher military education (HMEI). 271 cadets participated in the investigation. An experimental group (EG) was formed with cadets participating in sports ($n = 63$) and a control group (CG) that involved cadets studying according to the traditional physical training system ($n = 208$). Academic performance was estimated according to the results of mastering different disciplines, mental capacity, according to

the Burdon-Anfimov test. It is determined that the EG cadets had better indicators of academic performance and mental ability than the CG cadets.

KEY WORDS: cadets, academic performance, mental capacity, studying activity, sport.

INTRODUCTION.

According to Order of the Minister of Defense of Ukraine "On approval of the Regulation on the peculiarities of the educational process organization at the higher military educational establishments of the Ministry of Defense of Ukraine and military educational units of higher educational establishments of Ukraine" No. 346, the educational process is an intellectual, creative activity in the field of higher military education and science, carried out in higher military educational institutions through a system of scientific-methodological, pedagogical, teaching and educational measures and aimed at the transfer, assimilation, multiplication and use of the knowledge, skills and other competencies of cadets, as well as the formation of a harmoniously developed personality (2015).

The educational process at HMEI provides the opportunity for cadets to acquire general and professional competences in the humanitarian, social, scientific, technical and military spheres necessary for professional activity and their intellectual, moral, spiritual, aesthetic and physical development (Sergienko, & Andreianov, 2013; Kamaiev et al., 2018).

Concerning military and political situation in Ukraine, war fighting in the east of our country for its independence, the requirements for the quality of studying and training of the future officers of the Armed Forces of Ukraine are growing significantly. Therefore, the educational process in modern HMEI is under conditions connected with the constant increase in the amount of educational information, a high level of responsibility for educational results, high nervous and emotional stress,

overload in the intellectual sphere, decreased motor activity of cadets (Bolotin, Bakayev, & Vazhenin, 2016; Lenart, 2019; Martins, 2018; Prontenko et al., 2019).

The weekly time budget of the cadets' education is 54 hours (including self-education), and the daily intellectual load is 8–9 hours. A large number of cadets being unable to manage their time budget, conduct their self-education in the evening (or at night) and on weekends (Borodin, 2009; Blacker et al., 2011; Prontenko et al., 2018).

The rich intellectual activity of cadets is characterized by considerable brain tension which leads to rapid exhaustion (Gordon, 1999; Vilensky, 2001; Korobeinikov, 2002; Ghoncharenko, & Novykova, 2010; Muntjan, 2010). These factors have a negative effect on the academic performance of cadets. In particular, low motor activity (hypokinesia) leads to various disorders of the body systems, metabolism, overweight, and worsens the condition of the muscular system (Bulych, & Muravov, 2002; Korolchuk, & Kraynyuk, 2006; Poddubniy, Sukhorada, & Kirpenko, 2009). Muscles become soft, decrease in size, and the muscular corset does not perform its main function (the spine is not held in a normal position) that leads to worsened cerebral blood supply and consequently to decreased mental capacity of cadets (Wilmore, & Costiill, 2004; Futornyj, 2011; Bezpaliy, 2012; Oliver et al., 2017). All this has a negative influence on the academic performance of cadets and, accordingly, it reduces the efficiency of the future professional activity performance.

The analysis of the works of many scientists proved (Kuznetsova, & Kuts, 2005; Griban, 2008; Montesano, & Mazzeo, 2019) that systematic physical exercises and sport cause the reduction of the negative effects of the studying activity at the modern HMEI, improve the brain performance and, as a result, improve the academic performance of cadets. Summarizing the works of many scientists (Karpukhina, 2009; Humenny, 2011; Bezpaliy, 2012), it should be noted that the main tasks of physical exercises and sports for cadets in the process of intense intellectual activity are:

- To change the dynamics of cortical processes, create the optimal background of excitability, including in the work a large area of the motor analyzer.
- To eliminate congestion, improve cerebral circulation and metabolism, actively affecting all systems of the body.
- To strengthen adaptation influence on cortical nerve centers, improve emotional state.
- To exert a preventive influence on the musculoskeletal system and digestive organs by activating the motor function.

DEVELOPMENT.

Methodology.

The aim of the article is to investigate the influence of sports classes on the level of studying activity of cadets and the dynamics of their mental capacity during studying at HMEI.

Two hundred seventy-one cadets of S. P. Koroliov Zhytomyr Military Institute, aged 18–25, who were graduates in 2016–2018 took part in the research. Two groups were formed: experimental group (EG) which included the cadets who were engaged in a sports teams of the institute, participated in competitions and completed sports grades in that kind of sport ($n=63$), and control group (CG) which involved the cadets who were studying according to the traditional forms of physical education at HMEI ($n=208$).

The academic performance of cadets was investigated according to their results in mastering practical (general-military) disciplines, theoretical disciplines and special disciplines (according to the future military specialty, starting from the 3rd year of studying) in each year of studying (the average grade of each cadet and the average grade of EG and CG) and according to the final average grade for 4 years of study (the level of higher education is the Bachelor's degree). The academic performance indicators were obtained in the Military Institute's Studying Department.

The research of the cadets' mental capacity was conducted according to the Burdon-Anfimov's test (Raygorodsky, 2001; Korolchuk, & Kraynyuk, 2006). The cadets received blanks with 1480 characters (37 lines with 40 characters each). The task was to consistently underline letters "K" and to cross letters "H" out in each line looking through the horizontal lines of letters. Additionally, the task was to process as many characters as possible and make as few mistakes as possible. The task was completed within 10 minutes.

During the test the experimenter gave a command "Line" every minute and cadets had to put a vertical bar in the place where they stopped when they had heard the command. The following issues were taken into account: the total number of correctly processed characters, incorrectly processed letters, and missed letters "K" and "H". The mental capacity (the efficiency of work, E) of cadets was defined as the product of the indicator of work accuracy (A) and the total number of the processed characters of proofreading table (S) by the formula:

$$E = A \cdot S. \quad (1)$$

where E – mental capacity.

A – the indicator of work accuracy.

S – the total number of processed characters.

The indicator of work accuracy (A) was determined by the formula:

$$A = (C - W) / (C + O), \quad (2)$$

where C – the total number of underlined and crossed out letters.

W – the number of incorrectly underlined and crossed out letters.

O – the number of missed letters "K" and "H".

The aim of the evaluation was to determine the performance in each one-minute period and totally during 10 minutes according to Table 1.

The study of the mental capacity of cadets was conducted by the officers of the Department of Moral and Psychological Support of S. P. Koroliiv Zhytomyr Military Institute.

Table 1. The evaluation of the mental capacity of cadets (c.u.).

The value range of mental capacity (E)	The level of mental capability
1406 and more	High
1258–1405	Above the middle
1111–1257	Middle
961–1110	Below the middle
960 and less	Low

The scientific methods which were used to realize the tasks of the research: theoretical analysis and generalization of literature, pedagogical observation, experiment, testing, statistical analysis. During the researches the authenticity of difference between the indicators of cadets by means of Student's t-test was determined. The significance for all statistical tests was set at $p < 0.05$.

Researches related to the involvement of cadets were carried out in compliance with all relevant national regulations and institutional policies (Order of the Minister of Defense of Ukraine "On Approval of the Regulation on the Organization of Scientific, Scientific and Technical Activities in the Armed Forces of Ukraine" dated 27.07.16, No. 385). Informed agreement was received from all people involved in this research.

Results and discussion.

The great attention to the physical and athletic improvement of future officers is paid traditionally in Zhytomyr Military Institute. All the necessary conditions are created in order to realize it: the daily schedule includes time for sports, the modern sports base is prepared, sports sections of 12 kinds of sports (hand-to-hand combat, kettlebell lifting, military multidiscipline event (polyathlon),

military pentathlon, armports, powerlifting, crossfit, football (futsal), basketball, volleyball, tug of war, table tennis) work actively, the training process is provided by professional trainers.

Every year the most trained cadets participate in international competitions, championships of Ukraine and the Armed Forces of Ukraine, regional competitions where they complete sports grades (the 1st grade, Candidate of Master of Sports (CMS)) and receive sports titles (Master of Sports of Ukraine (MS), Master of Sports of Ukraine of the International Class (MSIC)). The analysis of the lists of the institute's teams showed that 22 cadets out of 112 graduates (19.6%) took part in sports and completed sports grades in 2016, 26 cadets out of 79 graduates in 2017 (32.9%), 15 cadets out of 80 graduates in 2018 (18.8%). In total, 63 graduates of 2016–2018 were included in EG that comprises 23.2%. The cadets who were engaged in sports without a sports classification (crossfit, military pentathlon) or who did not complete any sports grade (tug of war, volleyball) were included in CG. The results of the ratio of graduates of 2016–2018 who were engaged in various sports and completed sports grades or gained sports titles during their studying at HMEI are given in Table 2.

The analysis of Table 2 showed that most of the cadets completed the 1st sports grade – 31 cadets (49.2%), 24 cadets completed CMS (38.1%), and 8 cadets gained MS and MSIC titles (12.7%). The cadets who were involved in kettlebell lifting (23.8%), military multidiscipline event (19%) and hand-to-hand combat (17.5%) training completed the largest number of sports grades and classification standards during the studying at HMEI. The cadets of basketball (4.8%) and table tennis (3.2%) teams completed the least number of sports grades.

In order to study the academic performance of cadets, we analyzed the summarized data of cadets' average grades which are included in the certificates of Bachelor's degree application, concerning two indicators:

- The average grade for three blocks of disciplines (practical, theoretical and special) in each odd semester of studying.
- The average grade for 4 years of studying at HMEI.

Table 2. The ratio of EG cadets (the graduates of 2016–2018) who were engaged in different kinds of sports during the studying, concerning the level of sports qualification (n=63, number of people / %).

Sports types	Sport qualification levels			Total number of grades and titles	Ranking place
	The 1 st grade	CMS	MS, MSIC		
Kettlebell lifting	5 / 7.9	6 / 9.5	4 / 6.4	15 / 23.8	1
Military multidiscipline event (polyathlon)	6 / 9.5	4 / 6.4	2 / 3.2	12 / 19.0	2
Hand-to-hand combat	6 / 9.5	4 / 6.4	1 / 1.6	11 / 17.5	3
Powerlifting	4 / 6.4	2 / 3.2	1 / 1.6	7 / 11.1	4
Armsport	3 / 4.8	4 / 6.4	-	7 / 11.1	5
Football (futsal)	2 / 3.2	4 / 6.4	-	6 / 9.5	6
Basketball	3 / 4.8	-	-	3 / 4.8	7
Table tennis	2 / 3.2	-	-	2 / 3.2	8
Total number of grades and sports titles	31 / 49.2	24 / 38.1	8 / 12.7	63 / 100	

The investigation of the cadets' academic performance concerning all disciplines indicates no significant difference in the EG and CG cadets' academic performance during all years of studying ($p>0.05$). Additionally, the average grade in all groups was significantly improved ($p<0.05-0.001$) during the experiment: it becomes 0.63 points better for practical disciplines block, 0.84 points better for theoretical disciplines block, 0.49 points better for special disciplines block in EG, and 0.42 points better for practical disciplines block, 0.76 points better for theoretical disciplines block, 0.26 points better for special disciplines block in CG (Table 3).

It is especially important, that the average grade of the EG cadets (4.18 points) is even slightly higher than the one of the CG cadets (4.16 points) for the block of special disciplines which promote the basics for the future professional activity mastering. The analysis showed that

rationally organized sports do not interfere the educational process, and also contribute to the improvement of the results of studying the practical, theoretical and special disciplines by cadets.

Table. 3. The dynamics of the indicators of academic performance of EG and CG cadets during studying at HMEI (Mean $\pm$ SD), average grade.

The year of studying	EG (n=63)	CG (n=208)	Significance value
Practical (general-military) disciplines			
1 st year	3.42 $\pm$ 0.19	3.61 $\pm$ 0.13	p>0.05
2 nd year	3.63 $\pm$ 0.18	3.75 $\pm$ 0.12	p>0.05
3 rd year	3.87 $\pm$ 0.17	3.89 $\pm$ 0.11	p>0.05
4 th year	4.05 $\pm$ 0.16	4.03 $\pm$ 0.10	p>0.05
p(1–4)	<0.05	<0.01	
Theoretical disciplines			
1 st year	3.17 $\pm$ 0.21	3.22 $\pm$ 0.14	p>0.05
2 nd year	3.39 $\pm$ 0.20	3.57 $\pm$ 0.13	p>0.05
3 rd year	3.67 $\pm$ 0.19	3.69 $\pm$ 0.13	p>0.05
4 th year	4.01 $\pm$ 0.17	3.98 $\pm$ 0.13	p>0.05
p(1–4)	<0.01	<0.001	
Special disciplines			
3 rd year	3.69 $\pm$ 0.17	3.90 $\pm$ 0.12	p>0.05
4 th year	4.18 $\pm$ 0.15	4.16 $\pm$ 0.10	p>0.05
p(3–4)	<0.05	<0.05	

Legend: Mean – arithmetical average; SD – standard deviation; n – number of subjects; p – significance of difference between the indicators of the EG and CG cadets; p(1–4) – significance of difference between the indicators of the cadets of the 1st and the 4th years of study; p(3–4) – significance of difference between the indicators of the cadets of the 3rd and the 4th years of study.

The ratio of the EG and CG cadets (concerning their sports qualification) according to the average grade for 4 years of studying is shown in Table 4. The analysis of the academic performance of the cadets who were engaged in sports during studying showed that most of EG cadets (38.2%) had an average grade for the whole period of study (4 years) 4–4.5 points; 25.4% EG cadets were determined to have an average grade higher than 4.5 points – they received the Degree Certificate with Distinction; 23.8% EG cadets had an average grade 3.5–4.0 points; 6.3% EG cadets had an average grade 3.0–3.5 points. It is important to note that 6.3% EG cadets received the Degree Certificate with Distinction and gold medal (with average grade 5.0 points) that proves high

academic performance of the cadets who were engaged in sports during the studying at HMEI. It also should be mentioned that 1 cadet among the sportsmen of high qualification (MS, MSIC) received gold medal and there were no cadets determined having an average grade below 3.5 points (Table 4).

The most of CG cadets had an average grade 3.5–4.0 points (38.9%) and 3.0–3.5 points (30.8%); 12% CG cadets received the Degree Certificate with Distinction; and only 1.9% – gold medal (Table 4). The conducted investigation proved that EG cadets have significantly better results than the CG cadets concerning an average grade that shows a positive influence of sports classes on the academic performance of cadets.

Table 4. The ratio of EG and CG cadets (the graduates of 2016–2018) concerning their academic performance (the average grade for 4 years of studying, n=271, number of people / %).

The average grade for 4 years of studying	EG (n=63)				CG (n=208)
	The 1st grade	CMS	MS, MSIC	In total	
5.0	2 / 3.2	1 / 1.6	1 / 1.6	4 / 6.3	4 / 1.9
4.5 – 5.0	8 / 12.7	6 / 9.5	2 / 3.2	16 / 25.4	25 / 12.0
4.0 – 4.5	12 / 19.0	9 / 14.3	3 / 4.8	24 / 38.2	34 / 16.4
3.5 – 4.0	6 / 9.5	7 / 11.1	2 / 3.2	15 / 23.8	81 / 38.9
3.0 – 3.5	3 / 4.8	1 / 1.6	-	4 / 6.3	64 / 30.8

The important indicator of the studying activity efficiency of cadets is also mental capacity. According to the available terminology, the working capacity is the person's potential to perform the maximum amount of work (mental or physical) during the restricted time period and with certain intensity (Korobeinikov, 2002; Bulych, & Muravov, 2002).

During mental work, filling the blood vessels of the brain is increased, the peripheral vessels of the limbs are narrowed, the vessels of the internal organs are enlarged, that is, the vascular reactions are opposite to those peculiar for muscular loading. It is proved that physical exercises actively influence the efficiency of educational and professional activity, the level of mental capacity; they

are used for the prevention and elimination of mental exhaustion (Griban, 2008; Karpukhina, 2009; Humenny, 2011).

The mental capacity of cadets was investigated through the Burdon-Anfimov's test and determined as the product of the indicator of work accuracy and the total number of the processed characters of proofreading table. The aim of the evaluation was to determine the performance in each one-minute period and totally during 10 minutes. Besides, the analysis of the dynamics of mistakes during every minute was conducted.

Applying the Burdon-Anfimov's test, we investigated the performance of the nervous system of cadets at the end of their studying at HMEI, that is, the mental capacity that underlies any activity. The peculiarities of this performance are reflected in our study through activity the essence of which lies in the perception and processing the information according to certain rules. The efficiency of the cadets' educational activity depends on what kind of volitional effort the cadets' nervous system is capable and how long it can work without being tired. The results are shown in Fig. 1.

The cadets who were engaged in sports (EG) and completed classification standard of CMS are determined to have the highest level of mental capacity (1289.6 ± 22.45 c.u.). These results do not differ authentically ($p > 0.05$) from the results of the cadets who are sportsmen of the 1st grade (1267.4 ± 22.07 c.u.), MS and MSIC (1272.4 ± 26.51 c.u.) (Fig. 1). The cadets who were not engaged in sports were defined to have the worst level of mental capacity (1227.5 ± 10.20 c.u.). This result is 62.1 c.u. worse authentically than the results of EG cadets who completed the classification standard of CMS ($p < 0.05$) and do not differ authentically from the results of EG cadets completed the 1st grade and received sports title of MS and MSIC ($p > 0.05$). According to the table of rankings of mental capacity (Table 1), the level of mental capacity of EG cadets (of all level of sports qualification) is evaluated as above the middle, the cadets of CG – as middle. The conducted

analysis proved a positive effect of sports classes on the level of cadets' mental capacity and respectively their academic performance.

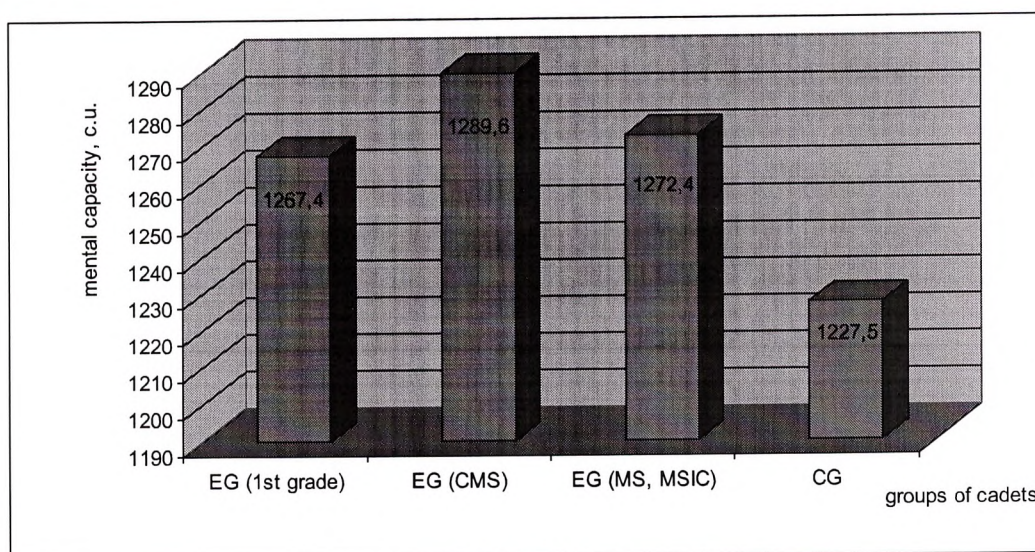


Fig. 1. The level of mental capacity of the cadets (graduates of 2016–2018) who were engaged in sports (EG, n=63) and completed sports grades and titles (the first grade, CMS, MS and MSIC), and the cadets who were not engaged in sports during studying (CG, n=208), c.u.

The analysis of the test performed at intervals of a minute by EG and CG cadets showed that the level of mental capacity of EG cadets is higher than the one of CG during all the minutes studied, but the results of cadets of both groups did not differ significantly from the 1st to the 6th minute ($p>0.05$), at the 7, 8, 9, and 10th minutes, the indicators of EG cadets are significantly better than that of CG cadets ($p<0.05$) (Fig. 2).

The analysis of the dynamics of mistakes distribution during the test by EG and CG cadets showed that the increase in the number of mistakes (incorrectly crossed out and underlined letters "K" and "H") at the end of the test of the CG cadets proves their increase in exhaustion, deterioration of stability of attention, volitional qualities and, as a result, decrease in mental capacity. Conversely, a roughly stable chart of mistakes distribution indicates a high level of stability of attention and mental capacity of EG cadets (Fig. 3).

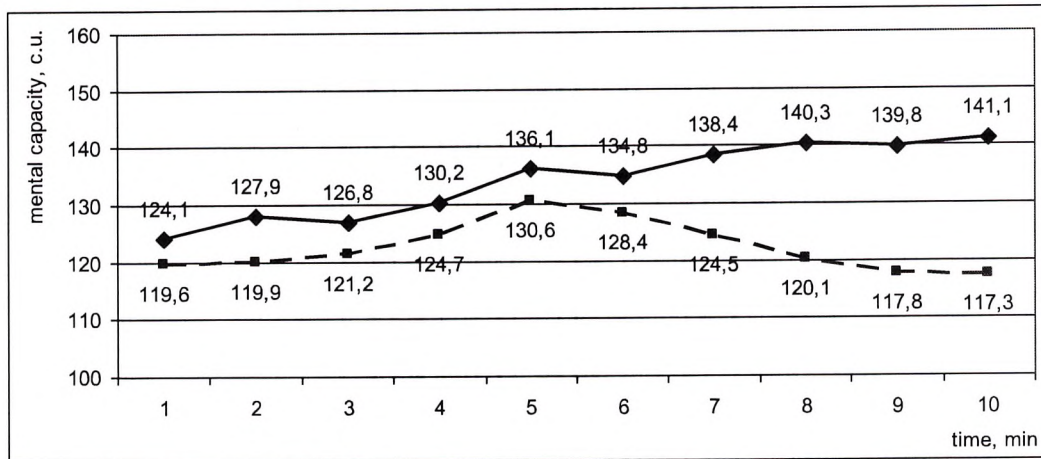


Fig. 2. The dynamics of the mental capacity of EG (n=63) and CG (n=208) cadets concerning the results in the Burdon-Anfimov's test (c.u.)

- the indicators of the mental capacity of EG cadets.
- the indicators of the mental capacity of CG cadets.

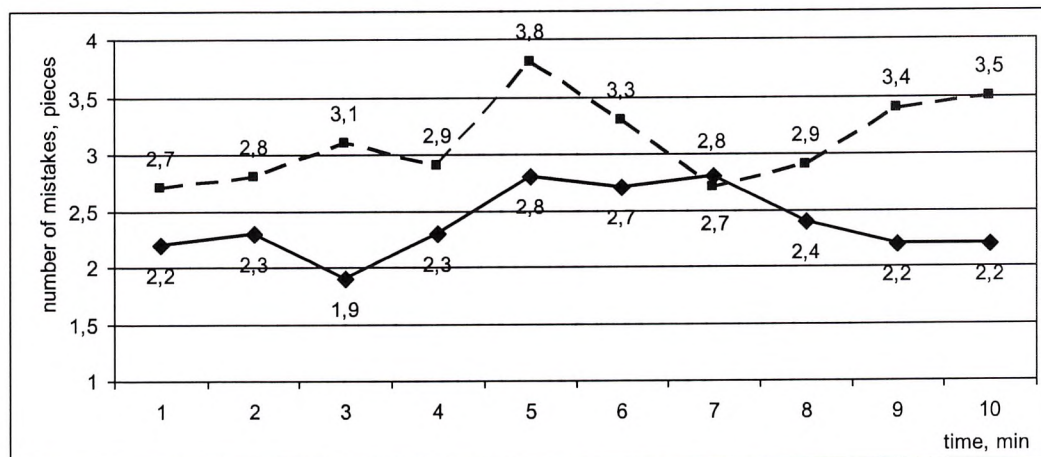


Fig. 3. The dynamics of the mistakes distribution during the Burdon-Anfimov's test performance by EG (n=63) and CG (n=208) cadets (c. u.).

- the indicators of the mental capacity of EG cadets.
- the indicators of the mental capacity of CG cadets.

The number of mistakes of the EG cadets is less than the number of the CG cadets (except the 7th minute), but the difference is not authentic ($p > 0.05$). The number of mistakes of EG cadets is less authentically than the number of mistakes of the cadets who were training according to the traditional system of physical training at HMEI just at the 10th minute ($p < 0.05$). Therefore, the

results of cadets testing through the Burdon-Anfimov's test state the improvement of the mental capacity of EG cadets as the result of sports activities.

CONCLUSIONS.

The investigation of the cadets' academic performance showed that the most of the EG cadets (38.2%) had an average grade during the studying 4–4.5 points; 25.4% EG cadets are determined to have more than 4.5 points (they received the Degree Certificate with Distinction); 23.8% EG cadets had an average grade 3.5–4.0 points; 6.3% EG cadets had an average grade 3.0 – 3.5 points; 6.3% EG cadets received the Degree Certificate with Distinction and gold medal (with an average grade 5.0 points). Additionally, 1 cadet among the sportsmen of high qualification received gold medal and there were no cadets determined having an average grade below 3.5 points that proves high academic performance of the cadets who were engaged in sports during the studying at HMEI.

The most CG cadets had an average grade 3.5–4.0 points (38.9%) and 3.0–3.5 points (30.8%). 12% CG cadets received the Degree Certificate with Distinction, and 1.9% – gold medal. The conducted investigation proves that EG cadets have significantly better results than CG cadets that shows a positive influence of sports classes on the cadets' academic performance.

The cadets who were engaged in sports and completed classification standard of CMS are determined to have the highest level of mental capacity (1289.6 ± 22.45 c.u.) and the cadets who were not engaged in sports were defined to have the worst level of mental capacity (1227.5 ± 10.20 c.u.). Besides, the level of mental capacity of EG cadets (of all levels of sports qualification) is evaluated as above the middle, the level of CG cadets – as middle.

Therefore, a rational combination of sports and studying does not harm the educational process, but also promotes the learning of general-military, theoretical and specialized disciplines and improves the efficiency of future professional activity.

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