

Dynamics of functional state of artillery reconnaissance cadets during training and combat activities

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Abstract

It is well-established that a person's post-exercise condition is best characterized by the indicators of the body's functional systems during the recovery period. Functional physical condition is a comprehensive measure of the extent to which all basic vital biological functions, organs, and systems, contribute to the servicemen's high, adequate, or inadequate (low) level of physical performance. This condition is closely linked to the readiness of soldiers for military and professional duties, for performing specific special actions, movements in difficult combat conditions and the impact of various adverse factors: stress, physical and mental stress, acceleration, swaying, vibration, high or low temperatures, oxygen deprivation, noise. Physical training is an important means of ensuring a high level of combat readiness of each serviceman in the modern. *Purpose:* to determine the influence of orienteering on the dynamics of functional indicators of cadets and their recovery after passing different distances. *Material and Methods:* Objects: 66 healthy cadets of a military educational institution studying artillery intelligence. The competition program included six orienteering exercises, namely: sprint, middle and long distance of choice, middle distance in a given direction in the city, middle distance on a marked track and middle distance of choice, which was held in the dark. The study was conducted 2 times for 1 hour on weekdays and 3 hours on weekends and holidays. All participants of our study gave their informed consent to participate in the experiment. Research was conducted and performed in accordance with the ethical standards of the Declaration of Helsinki.

Keywords: professional (combat) training, physical qualities, paramilitary, military personnel, functional status, training and combat activities.

Introduction

Physical training is an important means of ensuring a high level of combat capability of troops in any army. The high level of physical fitness of servicemen allows them to overcome great physical and mental stress, maintain the maximum level of performance and restore combat capability faster. In the system of combat training of servicemen-artillery reconnaissance men, physical training occupies an important place, because it actively affects all components of the warrior's combat capability. In the conditions of combat operations (exposure to significant physical and mental stress), servicemen with a high level of strength, endurance, speed, agility prevail in many indicators of military professional activity of servicemen whose level of these qualities is much lower (Prystupa Ye., Romanchuk S., 2012).

It has been scientifically proven that successful learning of military-applied, special skills (military-vocational training) is impossible without proper development of physical abilities. These abilities are necessary for the ability to move quickly on the ground, navigate in space, overcome various obstacles, swim (including swimming in uniform with weapons), ski, etc. without a sufficient level of endurance, strength, speed, etc. (Olkhovyi O., Korchagin M., 2010; Nebozhuk O., Oderov A. et al., 2023; Oderov A., Babych M., Dunets-Lesko A., Shlyamar I. et al., 2023).

Numerous studies (Popovych O., Romanchuk S., 2010; Leshchynskyi O., Pervachuk O., Babych M., Nebozhuk O., Bogdanov M., Bubon V., Abramenko O., Khachatryan A. et al. 2023; Klymovych V. et al. 2019) have proved that the most complete state of a person after exercise is characterized by indicators of the functional systems of the body during the period of their recovery. The influence of loads on individual functions

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and organs of servicemen who are not actively involved in sports, determination of optimal rest intervals are considered in many scientific work (Malikov M., Bohdanovska N., Svatyev A., 2006; Nebozhuk O., Oderov A. et al., 2023; Babych M., Romanchuk S., Oderov A., Tychyna B., Yuryev S. Arabadzhiev T. et al., 2024).

Studies by Oderov A., Babych M., Anohin Y., Tychyna I., et al. show that strength, speed, and speed and power qualities reach their optimal development already in the basic period of cadets' training and then change slightly. Their stabilization takes place. Such physical qualities as speed, special and speed-power endurance are further improved.

All the various actions and the nature of the loads that cadets - artillery reconnaissance men receive during training and combat activities are largely similar to the effects of orienteering exercises.

In our opinion, in the system of physical training of cadets, the current place should be occupied by military (sports) orientation exercises, which have a certain impact on the professional skills of cadets and contribute to the development of the necessary physical qualities to improve professional specific motor skills. Therefore, when assessing the consequences of training sessions, it is important to have a clearer idea of the peculiarities of the recovery of the body of cadets when they apply orienteering exercises.

Materials and methods

Objects: 66 healthy cadets of a military educational institution studying artillery reconnaissance. The competition program included six orienteering exercises, namely: sprint, medium and long distance of choice, average distance in a given direction in the city, average distance on a marked track and average distance of choice, which took place in the dark. Cadets were engaged in accordance with the schedule of the Academy and the instructions of the Ministry of Defense of Ukraine: twice for 1 hour on weekdays and for 3 hours on weekends and holidays. The age and length of military service of cadets did not differ significantly ($p > 0.05$).

All participants of our study gave their informed consent to participate in the experiment. Research was conducted and performed in accordance with the ethical standards of the Declaration of Helsinki.

Methods. The researchers studied the nearest period of restitution after exercise in the following sequence: first, they took data before orienteering, immediately after its completion, 3 minutes after the end of the exercise and an hour later. Changes in the state of the CNS and neuromuscular apparatus were studied by the following indicators: concentration, speed of motor reactions to light and sound stimuli, accuracy of estimating the time of effort, tremometry, speed-force movement (long jump from a place). Power qualities were studied on the indicators of hand dynamometry and long jump from a place.

Testing of cadet indicators was carried out at the permanent deployment point of the National Army Academy named after Hetman Petro Sagaidachny during June-August 2023.

To measure arterial pressure (AP), electrodes for recording an electrocardiogram were fixed on the chest, and a cuff was applied to the shoulder.

The assessment of the reliability of differences was evaluated using Student's t-criterion to determine the difference between two means, respectively, in the case of normal and non-normal distributions of individual values in each sample. The baseline was a 5% level of significance ($p < 0.05$). When analyzing data within the sample, the values of these criteria for related samples were used, and when analyzing data between different groups for unrelated samples.

Results

One of the tasks of the study was to determine the dynamics of functional indicators of cadets and their recovery after passing various orienteering distances.

Studies of the effect of orienteering exercises on cadet performance on simple motor response to sound showed significant changes in the results of the exercise at the sprint distance ($t = 2.732$; $p < 0.01$), at medium distance ($t = 2.758$; $p < 0.01$), at a long distance ($t = 2.462$; $p < 0.05$), at an average distance in a given direction in the city ($t = 2.733$; $p < 0.01$). A significant difference in the indicators of simple motor response to the sound of cadets after performing exercises at an average distance along the marked track ($t = 1.545$; $p > 0.05$) and for the average optional distance, which was carried out in the dark ($t = 1.166$; $p > 0.05$) (table 1.).

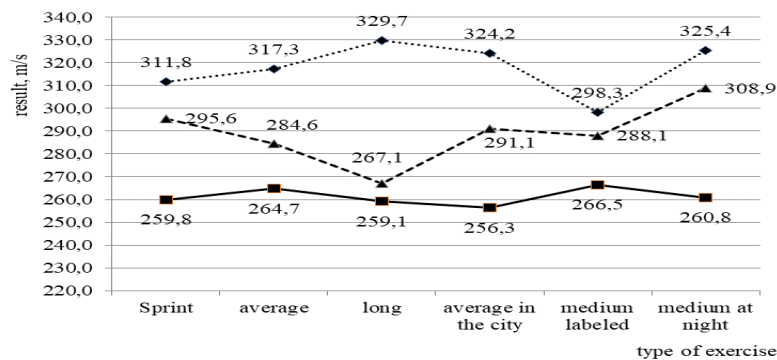
Table 1. PSMR indicators for the sound of cadets under the influence of various orienteering exercises, m/s

distance	before exercise		after exercise		3 min after exercise		1 hour after exercise	
	X	m	X	m	X	m	X	m
sprint	321.4	15.9	401.2	24.5	384.3	21.9	324.5	16.9
average	317.6	14.4	389.2	21.6	342.0	20.7	319.3	19.8
long	329.4	16.5	398.3	22.6	360.5	23.7	333.8	21.5
average in the city	321.1	15.6	390	19.8	364.2	18.6	325.4	18.6
medium labeled	319.2	13.8	356.5	19.8	342.8	18.2	316.5	15.6
medium at night	322.8	15.4	344.6	22.5	334.8	16.8	316.1	18.4

We determined that the recovery of cadets after performing orienteering exercises is rather slow. For three minutes of rest after the exercise, the indicators of cadets in simple motor response to sound are reliably equal to the indicators obtained after the exercise ($t=0.349-1.577$; $p>0.05$). We also determined that only the indicators of cadets obtained 3 minutes after the sprint are significantly different from the initial data ($t=2,324$; $p<0.05$). The results of cadets obtained 3 minutes after performing other orienteering exercises do not significantly differ from the initial data obtained before performing the exercises ($t=0.526-1.775$; $p>0.05$).

Studies have shown that the greatest changes in the indicators of cadets from simple sensorimotor reaction to sound are determined under the influence of loads at the sprint distance ($\Delta X=79.8$ ms; 24.8%), average distance ($\Delta X=71.6$ ms; 22.5%), long distance by choice ($\Delta X = 68.9$ ms; 20.9%) and the average distance in a given direction in the city ($\Delta X=68.9$ ms; 21,5%). Less effect on changes in the indicators of PSMR cadets on the sound of performing exercises at an average distance along the marked track ($\Delta X=37.3$ ms; 11.7%) and the average distance of choice, which was carried out in the dark ($\Delta X=21.8$ ms; 6,8%).

Studies of simple sensorimotor reaction indicators on the light of cadets who were engaged in the orienteering section before and after the exercise made it possible to determine the deterioration of test results under the influence of physical activity (fig. 1).



Notes:

- - indicators of cadets before the exercise;
- - indicators of cadets after the exercise;
- - - - indicators of cadets after 3 minutes of rest after the exercise.

Figure. 1. Simple sensorimotor reaction dynamics on the light signal of cadets under the influence of various orienteering exercises, m/s

After the exercise at the sprint distance, the indicators of simple sensorimotor reaction cadets for the light signal (311.8 ± 18.9 ms) are significantly worse than the indicator before the exercise (259.8 ± 14.6 ms) ($t=2.177$; $p<0.05$). The results obtained 3 minutes after the completion of the exercise (295.6 ± 14.9 ms) are not significantly different from those obtained immediately after the completion of the exercise ($t=0.673$; $p>0.05$). This proves that the specified time is not enough to restore the sensory reaction of cadets, but, at the same time, the results obtained do not significantly differ from the initial data ($t=1,716$; $p>0.05$), which proves the readiness of the body systems to perform the next task.

Similar dynamics of simple sensorimotor reaction indicators for light was determined by the results of the study of cadets' indicators after the exercise at an average distance (317.3 ± 20.7 ms; $t=2,133$; $p<0.05$), at a long distance (329.7 ± 23.9 ms; $t=2,520$; $p<0.05$) and the average distance in a given direction in the city (324.2 ± 19.6 ms; $t=2,785$; $p<0.01$) relative to the initial data (264.7 ± 13.4 ms; 259.1 ± 14.6 ms; 256.3 ± 14.5 ms). There was no reliable difference between the indicators of cadets after the exercise at an average distance along the marked track (298.3 ± 16.8 ms; $t=1,445$; $p>0.05$) relative to the results obtained before the exercise (266.5 ± 14.2 ms). The largest changes in the simple sensorimotor reaction indicators for the light signal were determined by the results of the exercise at an average distance of choice, which was performed in the dark (325.4 ± 16.8 ms; $t=3,076$; $p<0.01$) relative to the initial data (260.8 ± 12.6 ms).

Studies of simple sensorimotor reaction indicators for the light of cadets after performing orienteering exercises proved that three minutes of rest are enough to restore the test results to the initial level. So, after the sprint, the simple sensorimotor reaction indicators for the light of cadets after 3 minutes (295.6 ± 14.9 ms) do not significantly differ from the baseline indicators ($t=1,716$; $p>0.05$), 3 minutes after the exercises at the middle (284.6 ± 17.9 ms) and long (267.1 ± 21.8 ms) distances, the cadets' indicators do not significantly differ from the initial data ($t=0.889$; $p>0.05$; $t=0,304$; $p>0.05$). Also, the indicators of cadets after 3 minutes of rest after performing exercises at an average distance of choice for the city (291.1 ± 18.2 ms) and the average marked distance (288.1 ± 16.3 ms) do not have a significant difference from the initial data ($t=1,495$; $p>0.05$; $t=0,999$; $p>0.05$).

Analysis of the results determined that the indicators of cadets with simple sensorimotor reaction for light (308.9 ± 17.9 ms) are not reliably restored in 3 minutes after performing an exercise at an average distance of choice, which was performed in the dark ($t=2.197$; $p<0.05$).

Studies of the tremometry indicators of cadets under the influence of various orienteering exercises showed that the technical task of the distance has a significant effect on the tremor of the cadets' hands. The exercise of choice significantly worsens the tremometry indicators of cadets, namely: after the sprint, the cadets' indicators worsened by 16.1 times (125.8%; $t=2.253$; $p<0.05$); after performing an exercise at an average distance, the cadets' tremometry indicators worsened by 13.4 times (114.5%, $t=2.034$; $p<0.05$), after completing the task at a long distance by choice, the cadets' indicators decreased by 17.5 times (142.3%, $t=2.138$; $p<0.05$) (table. 2.)

Table 2. Indicators of cadets tremometry under the influence of various orienteering exercises, times

distance	before exercise		after exercise		3 min after exercise		1 hour after exercise	
	X	m	X	m	X	m	X	m
Sprint	12.8	4.9	28.9	5.2	24.6	5.8	14.3	3.9
average	11.7	4.9	25.1	4.4	21.8	4.2	13.8	3.3
long	12.3	5.1	29.8	6.4	22.7	3.9	14.9	3.7
average in the city	10.6	4.4	31.5	5.2	28.6	5.1	18.6	5.4
medium labeled	9.8	3.3	32.5	5.2	27.1	3.9	17.9	5.5
medium at night	11.1	3.6	31.4	3.8	22.4	2.8	19.1	5.2

Technical complication of the task at a distance significantly worsens the tremometry of cadets. The tremometry indicators of cadets after performing an exercise at an average distance, which was established in the city, significantly worsen relative to the initial data by 20.9 times (197.2%; $t=3.068$; $p<0.01$), which is 7.5 times more than after performing an exercise at an average distance of choice. Performing an exercise at a marked average distance significantly worsens the tremometry indicators of cadets by 22.7 times (231.6%; $t=3.685$; $p<0.001$). Physical activity, features and technical difficulties of performing an exercise at an average distance at night lead to a significant deterioration in the tremometry indicators of cadets by 20.3 times (182.9%; $t=2.608$; $p<0.01$) relative to the initial data.

We have determined that the tremometry indicators of cadets who were received after three minutes of rest after performing all orienteering exercises do not significantly differ from those obtained immediately after the finish ($t=0.398-1.906$; $p>0.05$). That is, the specified time is not enough to restore the tremometry indicators of cadets after physical and psychological exertion. According to the results of our research, the dependence of the cadets' tremometry indicators on the technical complexity of the exercise was confirmed. Especially, this fact is confirmed by a reliable difference in the indicators of cadets after an hour of rest after the exercise.

The cadets' tremometry indicators obtained one hour after completing the exercises at the sprint (14.3 ± 3.9 times), average (13.8 ± 3.3 times) and long distances (14.9 ± 3.7 times) are significantly different from those obtained immediately after the finish ($t=2.246$; $p<0.05$; $t=2.054$; $p<0.05$; $t=2.015$; $p<0.05$).

Accordingly, the indicators of cadets obtained after an hour of rest after performing the average distance exercises in the city (18.6 ± 5.4 times), along the marked track (17.9 ± 5.5 times) and at night (19.1 ± 5.2 times) are reliably equal to the indicators of cadets obtained after completing the exercise ($t=1.720-1.928$; $p>0.05$). Thus, we have determined that after performing technically complex tasks at an average distance, the recovery of cadets' tremometry indicators is slower than after performing relatively simpler elective exercises at different distances. Studies of the results of dynamometry testing of a stronger arm of cadets before and after performing orienteering exercises showed reliable equality of indicators.

Thus, the dynamometry indicators of cadets after the exercise at an average distance (39.7 ± 2.7 kgf) do not significantly differ from the initial data that was obtained before the start (44.6 ± 2.7 kgf) ($t=1.283$; $p>0.05$). We found a significant difference between the indicators of cadets before (45.2 ± 3.1 kgf) and after (41.2 ± 3.6 kgf) the exercise at an average distance in the city ($t=0.841$; $p>0.05$), before (46.2 ± 2.4 kgf) and after (40.8 ± 3.8 kgf) exercise at an average distance along the marked track ($t=1.201$; $p>0.05$), as well as before (44.6 ± 2.7 kgf) and after (39.7 ± 2.7 kgf) performing an exercise at an average distance of choice, which was performed in the dark ($t=1.283$; $p>0.05$).

Significant changes in dynamometry indicators were determined based on the results of testing cadets before (44.8 ± 2.4 kgf) and after (37.1 ± 2.6 kgf) long-distance exercise ($t=2.176$; $p<0.05$), before (46.3 ± 3.5 kgf) and after (35.8 ± 3.9 kgf) exercise on the sprint distance ($t=2.003$; $p<0.05$) (fig. 2).

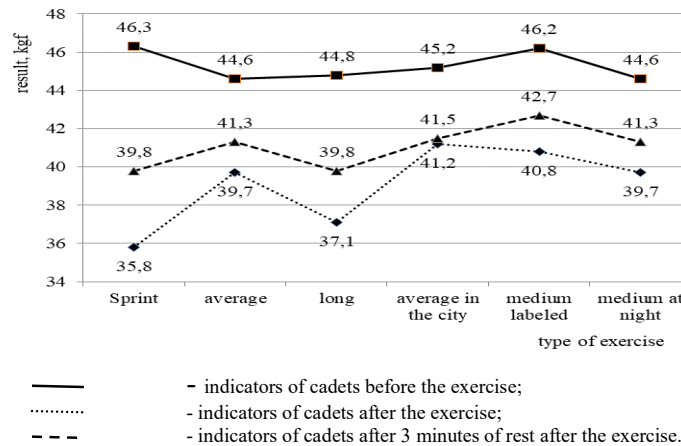


Figure. 2. Dynamics of dynamometry of a stronger arm of cadets under the influence of various orienteering exercises, kgf:

According to the results of the study of the impact of the physical and psychological load of orienteering exercises on the dynamometry indicators of a stronger hand, we determined minor changes before the start and after the finish by the cadets. A more informative indicator of the impact of orienteering exercise, in our opinion, will be a comparative study of the results of testing cadets on muscle sensation by 50% and 25% of the previously obtained result of dynamometry of a stronger hand.

Indicators of muscular sensation of cadets at 50% of the maximum indicator at rest has a deviation from 4.0% to 15.2%. Indicators of muscular sensation of cadets change significantly under the influence of physical and psychological stress of orienteering exercises. The greatest changes in the indicators of muscular sensation of cadets occurred after completing the battle at the sprint distance (20.7%) relative to the maximum dynamometry indicator. Significant changes were determined in the indicators of muscular sensation of cadets after performing exercises at an average distance (17.9%), a longer distance (17.0%), and also after performing an exercise at an average distance in the dark (16.9%).

We have determined that smaller changes in the indicator of muscular sensation of cadets by 50% of the maximum occurred after performing exercises at an average distance in the city (10.2%) and at a marked distance (9.3%). In our opinion, this is due to the technical complexity of the distance and the greater impact of these exercises on the performance of other functional body systems of cadets.

During the study, we proved that the recovery of the cadets' muscular sensations after performing orienteering exercises is fast. After three minutes of rest, the cadets' indicators differ from 50% of the maximum indicator by 8.9-17.1%, after an hour of rest - 4.5-12.7%.

Studies of muscle sensation indicators of cadets at 25% of the maximum dynamometry result revealed a different dynamics. Indicators at rest have deviations similar to those determined during the study of indicators of muscle sensation of cadets at 50% of the maximum result of dynamometry (4.9-14.3%).

We determined that under the influence of physical activity, the indicators of muscle sensation change the most after performing exercise at a long distance (21.3%) and an average distance (18.4%) by choice. Changes in cadets "indicators after performing technically more complex exercises are of less importance, namely: after an average distance in the city, the cadets' muscular sensation indicator changed by 13.6%, after performing the exercise at an average marked distance - by 15.7% and after performing the exercise at night - by 11.3%. These indicators differ from those obtained from the results of the study of muscular sensation indicators of cadets by 50% of the maximum dynamometry indicator, but the dynamics of these indicators have the same trends.

We note that the indicators of the muscular sensation of cadets in the recovery process have different dynamics. So, in the third minute of rest, the difference with 25% in the indicator of the maximum value of dynamometry is 14.8-17.6% and differs from the podium indicator with 50% of muscle size by 3-9%. After an hour of rest, the cadets' indicators of 25% muscle effort (1.8-8.7%) differ from those with 50% muscle effort (4.5-12.7%).

Studies of the indicators of the time sensation of cadets at the interval of 5 s showed that athletes involved in orienteering have a good sense of time. A significant difference after the exercise was found only by the results of testing after the sprint distance (3.2 ± 0.2 s) relative to the data obtained before the start (0.4 ± 0.7 s) ($t=3.846$; $p<0.001$). There was no significant difference between the indicators of cadets after performing other orienteering exercises and the initial data ($t=0.274-1.583$; $p>0.05$) (Fig. 3).

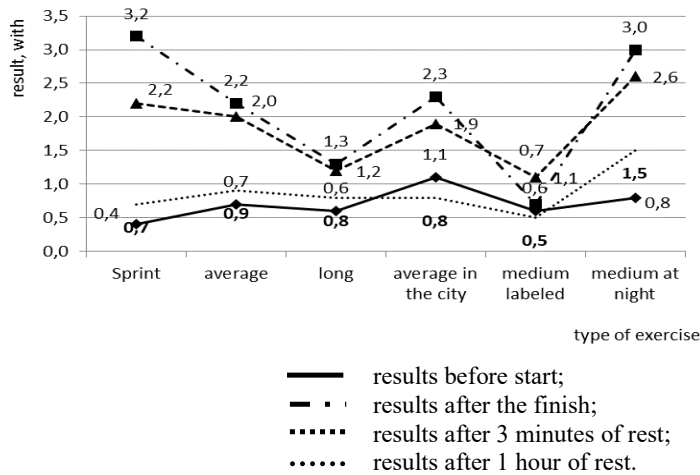


Figure. 3. Average time sensation of cadets (interval 5 s), s:

Note that the indicators of the feeling of time for cadets in the third minute of rest are equal to their indicators before starting the exercise ($t=0.316-1.313$; $p>0.05$), in addition to the results obtained after the cadets performed exercises for the sprint distance ($t=2.232$; $p<0.05$).

Analysis of the results of testing the sense of time of cadets at an interval of 10 seconds determined a different dynamics of indicators. After the exercises, a reliable difference in the indicators of the time sensation of cadets in the sprint distance (1.6 ± 0.4 s; $t=2,012$; $p<0.05$); in the middle distance (2.8 ± 0.7 s; $t=2,277$; $p<0.05$); in the long distance (3.9 ± 0.6 s; $t=2,474$; $p<0.05$); in the average marked distance (2.9 ± 0.6 s; $t=2,928$; $p<0.01$) and in the middle distance by choice, which was performed in the dark (4.5 ± 0.8 s; $t=3,104$; $p < 0.01$) (Fig. 4). No significant difference was determined between the initial data (1.6 ± 1.4 s) and the results obtained after performing (3.5 ± 1.1 s) an exercise at an average distance that was performed in the city ($t=1.067$; $p>0.05$).

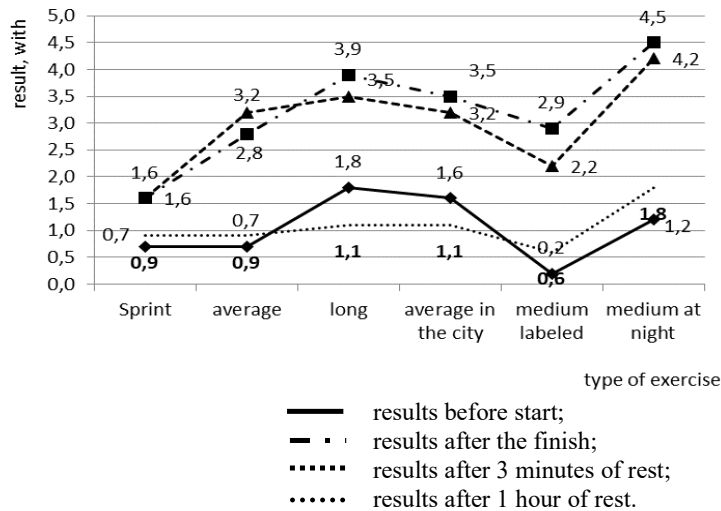


Figure. 4. Average time sensation of cadets (interval 10 s), s

It is determined that the indicators of cadets with a sense of time with an interval of 10 s after three minutes of rest do not significantly differ from those obtained immediately after the finish ($t=0.000-1.106$; $p>0.05$). Restoration of the indicators of the sense of time to the level of the initial data at the third minute of rest is determined after the sprint (1.6 ± 0.7 s; $t=1,236$; $p>0.05$), after a long distance (3.5 ± 1.8 s; $t=0,895$; $p>0.05$) and after the average distance in the city (3.2 ± 1.6 s; $t=0,752$; $p>0.05$). Analysis of the results of cadets with a sense of time after performing other exercises proved a significant difference with the initial data ($t = 2.159-2.747$; $p<0.05-0.01$).

According to the results of the study, a similar dynamics of cadets' indicators with a sense of time was revealed, but at an interval of 15 s. The indicators of cadets after performing orienteering tasks differ significantly from the initial data in all exercises ($t=2.163-5.050$; $p<0.05-0.001$), except for results obtained after performing long-distance tasks ($t=1.370$; $p>0.05$) (Fig. 5).

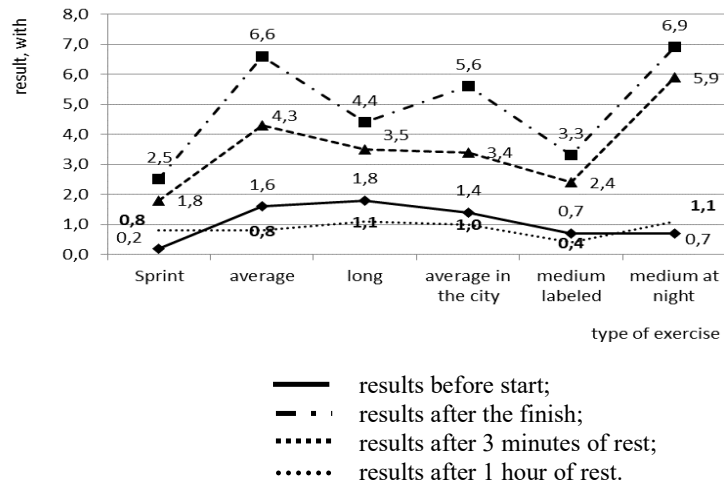


Figure. 5. Average time sensation of cadets (interval 15 s), s:

Note that on a longer time interval, a better recovery process after the exercise is determined. So, in the third minute of rest, the cadets' indicators significantly improved relative to the indicators obtained after the sprint distance (1.8 ± 0.2 s; $t=2,236$; $p<0.05$), after an average elective distance (4.3 ± 1.6 s; $t=2,004$; $p<0.05$), after the average for the marked route (2.4 ± 0.7 s; $t=2,169$; $p<0.05$) and after the average distance of choice, which was performed at night (5.9 ± 0.7 s; $t=4,515$; $p<0.001$).

An equally important indicator of the professional development of a soldier is the effective functioning of the body systems that are responsible for the development and improvement of psychological qualities. For an artillery scout, one of the important qualities is concentration. Therefore, we investigated the impact of various orienteering exercises and the process of restoring the concentration of cadets.

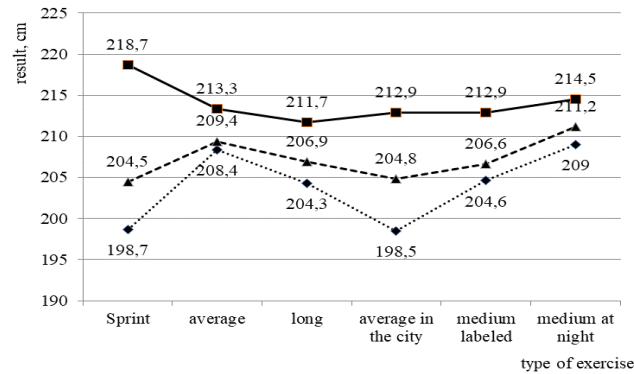
In the course of the study, we determined that after performing all the orienteering exercises, the cadet's concentration indicators will definitely worsen. After completing the exercise at the sprint distance, the cadets' performance worsened by 12.0 um.od. relative to initial data ($=2.631$; $p<0.05$); according to the results of testing after performing an exercise at an average distance of choice, the indicator significantly worsened by 10.1 um.od. ($t=2,205$; $p<0.05$). After performing more technically complex exercises, the indicators of concentration had the following changes: after the average distance that was carried out in the city, the indicators significantly worsened by 12.4 um.od. ($t=2,528$; $p<0.05$), after the average marked distance, the concentration of cadets significantly decreased by 15.7 units. ($t=2,947$; $p<0.01$), after the average elective distance, which was carried out in the dark by 13.6 units ($t=2.411$; $p<0.05$) (table 3).

Table 3. Indicators of concentration of attention of cadets under the influence of various orienteering exercises, d.

distance	before exercise		after exercise		3 min after exercise		1 hour after exercise	
	X	m	X	m	X	m	X	m
sprint	26.4	2.8	38.4	3.6	33.4	3.7	27.1	3.1
average	23.5	2.4	33.6	3.9	29.8	3	23.7	2.6
long	22.6	2.2	29.3	3.2	25.6	2.8	23.4	2.3
average in the city	24.1	3.1	36.5	3.8	33.4	4.1	23.8	3.9
medium labeled	24.1	3.4	39.8	4.1	36.5	3.8	26.4	3.0
medium at night	26.6	3.4	40.2	4.5	39.4	3.6	25.5	3.6

According to the results of the study of the influence of orienteering exercises, we did not determine a significant difference in the indicators of concentration of cadets after performing tasks at a long distance of choice ($\Delta X 7.3$ mind units; $t=1,725$; $p>0.05$). Thus, it can be noted that the indicators of concentration of cadets are more influenced by the complex technical tasks of the distance than the distance length.

This fact is confirmed by the results of the study of concentration of attention of cadets after a certain time of rest. After three minutes of rest after performing orienteering exercises, the cadets' indicators did not significantly change relative to the indicators after completing the exercise ($p>0.05$). We have determined that the indicators of concentration of cadets have a significant difference relative to the initial data, even after one hour of rest ($t=2,112-2,637$; $p<0.05$).



Notes: — indicators of cadets before the exercise;
 indicators of cadets after the exercise;
 - - - indicators of cadets after 3 minutes of rest after performance

Figure. 6. Dynamics of the results of a long jump from the place of cadets under the influence of various orienteering exercises, cm.

The study of the results of cadets on the exercise - long jumps from a place made it possible to determine that under the influence of orienteering tasks, indicators reliably change only after the sprint distance (198.7 ± 4.3 cm; $t=3,445$; $p<0.01$) relative to the initial data (218.7 ± 3.9 cm) and the average distance performed in the city (198.5 ± 4.6 cm; $t=2,286$; $p<0.05$) relative to the initial data (212.9 ± 4.3 cm) (Fig. 6).

The results of cadets from the jump to the length from the place do not have a significant difference in relation to the data that were obtained before the start of the remaining orienteering exercises ($p > 0.05$).

Table 4. Heart rate indicators of cadets under the influence of various orienteering exercises, bpm

distance	before exercise		after exercise		3 min after exercise		1 hour after exercise	
	X	m	X	m	X	m	X	m
sprint	68.7	6.2	150.7	6.4	110.3	5.8	69.3	5.2
average	67.7	6.0	149.2	6.1	109.3	5.5	68.3	6.2
long	71.2	5.8	145.5	7.3	108.6	5.4	75.6	4.9
average in the city	66.5	5.8	143.4	6.6	117.2	5.2	65.9	6.3
medium labeled	65.8	5.9	138.5	7.1	108.4	6.3	66.6	6.5
medium at night	66.8	6.2	139.9	5.8	99.4	5.4	65.2	3.6

Under the influence of exercise in the human body, the greatest changes occur in the performance of the cardiovascular system. Our research has made it possible to determine that orienteering exercises are no exception. After completing all orienteering exercises, the heart rate of cadets significantly increases by $73.1-82.0$ bpm relative to the initial data ($t=7.875-9.525$; $p<0.001$). After three minutes of rest, the heart rate of cadets is reliably restored relative to those that were obtained immediately after the finish ($t=3,118-5,110$; $p<0.01-0.001$), but they significantly exceed the heart rate of cadets obtained before the start ($t=3.965-6.508$; $p<0.001$).

Analysis of the results of measuring the heart rate of cadets after one hour of rest made it possible to determine that they are reliably equal to the heart rate of cadets at the beginning of the study ($t=0.069-0.579$; $p>0.05$) (Table 4). Competitive load on orienteering has many similar signs to the load of professional activity of artillery scouts. Their influence leads to a reliable deterioration of the functional indicators of all systems of the human body, namely those that characterize a simple motor reaction, the accuracy of muscle sensation, tremometry, the accuracy of time estimation, heart rate, a simple reaction to sound.

The conducted research was aimed at determining the peculiarities of the development of physical qualities, applied skills and functional capabilities of cadets and allowed to establish a certain mechanism for adapting their body in the process of becoming professional skills.

Discussion

The results of the study confirmed the conclusions of the scientific results of Kuznetsov M., Dukh T., 2022; Iedynak G., Sliusarchuk V., Mazur V., 2020 and others, which argue that the professional performance of military personnel is formed by repeated physical activity, and urgent adaptation is due to the consequences of a separate training load.

The problem of ensuring the proper state of physical fitness of military personnel is one of the main criteria for a general assessment of the effectiveness of their activities (Klymovych V., Oderov A., Korchagin M. et.al. 2020; Babych M., 2024).

The scientific works of scientists were devoted to highlighting the issues of physical preparedness of military personnel in extreme conditions by orienteering means in order to perform tasks for the purpose and use of orienteering means (Babych M., 2024; Oderov A., Babych M., Dunets-Lesko A., 2023; Tychyna I., Pidleteichuk R., Homanyuk, S. et.al., 2020).

The results of our research have expanded knowledge (Romanchuk S., Oderov A., Lesko O., Barashevsky S.,Badan Yu., 2022; Oderov A., Klymovych V., Korchagin M., Olkhovyi O. et.al., 2019; Romanchuk S., Oderov A.,Babych M., Klymovych V., Mandyuk A., Yarovoy M., Poltavets A., 2023) regarding the organization, conduct of orienteering classes for cadets of the Higher Educational Institution, which made it possible to determine the further direction of action in the aspect of introducing forms of physical education of cadets - future officers of the Ground Forces to increase the effectiveness of this pedagogical process in fulfilling the tasks of military professional activity. In addition, the obtained results and experience of training artillery scouts to participate in orienteering competitions of various levels (from the championship of the unit to the tournaments of the International Council of Military Sports (hereinafter referred to as SISM)) confirmed the conclusion that there are a number of problems in organizing forms of physical training with the use of orienteering in higher military educational institutions (hereinafter referred to as VVNZ) (Oderov A, Romanchuk S. et.al., 2022; Romanchuk S., Oderov A., Kuznetsov M. et.al., 2017).

Military and professional activity of servicemen of artillery reconnaissance units is inferior in intensity and tension to combat activity. The relationship of physical training with combat training activities is less clear and distinct. This leads to the erroneous opinion that the level of physical preparedness available to servicemen (acquired during everyday motor activity in the process of military service) is quite enough for the successful performance of their professional duties both in combat training and combat conditions. (Oderov A., Fishchuk I., Svyshch Y., Pylypchak I., Dukh T., Lashta V., 2022; Romanchuk S., Afonin V. et.al., 2022).

Research by Leshchinsky O., Pervachuk O., Babych M., Nebozhuk O., 2023; Romanchuk S., Oderov A., Babych M., Klymovych V., 2023 prove that the performance of combat missions by specialists of the Ground Forces continues to have a clearly defined motor component. It is the largest in terms of personnel assault and artillery reconnaissance units Anokhin E., Kuznetsov M., Dukh T., Barashevskiy S., Muzyka N.et.al (2022) argue that the use of physical exercises aimed at the development of common qualities will not lead to qualitative changes in the level of combat readiness of military personnel. Scientists Romanchuk S., Oderov A., Babych M., Klymovych V., 2023 prove that in the process of physical training it is necessary to apply exercises that would be close in structure to the professional actions of military personnel.

In our opinion, an effective means of solving the problem under study is the introduction of exercises that, in terms of content and conditions of execution, are as close as possible to real hostilities and create maximum physical and mental loads. We also believe that in the current conditions, an important factor is the need to prepare cadets of the specialty artillery intelligence to perform a combat mission for the purpose of quick orientation on the ground without GPS means. It is from such training of a warrior that the effective fulfillment of tasks of military professional activity by servicemen and the unit as a whole depends.

Conclusions

Studies aimed at determining the peculiarities of the development of physical qualities, applied skills and functional capabilities of cadets allowed to establish a certain mechanism for adapting their body in the process of becoming a professional skill.

It is revealed that the greatest influence on the functional state of the cadets' body is carried out by complex technical exercises of orienteering. Large physical and mental loads in orienteering exercises cause deep physiological shifts primarily in those functional systems that are leading for this exercise. So, the exercise at the sprint distance is accompanied by a significant deterioration in the activity of the auditory analyzer, concentration and increased tremometry. Performing tasks of medium distance of choice in the city worsens the indicators of coordination of movements, wrist dynamometry, tremometry, concentration of attention and muscle sensitivity. The biggest changes in the functional systems of the body occur after performing complex technical orienteering exercises and exercises at the sprint distance. In this case, the indicators of mental and motor functions, the cardiovascular system reliably deteriorate.

Among the indicators of the dynamics of the functional state of the cadets' body, the greatest changes under the exercise of exercises of soprtive orientation are the reaction to the load of the cardiovascular system, the accuracy of the sense of time and the excitability of the central nervous system according to the results of tremometry. This mechanism reveals the nature of development and orientation of the relationships of physical qualities, military-applied motor skills and functional capabilities of the cadets' body.

Taking into account the identified features, it seems promising to implement the obtained research materials in the process of physical training of cadets. Leading scientists proved that indicators of applied skills

have the greatest increase in the initial path of professional improvement in those exercises that are more related to the manifestation of strength, speed and speed-strength qualities.

For effective formation of attached skills by means of orienteering it is necessary to determine the phasing of individual sides of training depending on the solution of general and special tasks, from the initial physical and coordination abilities of cadets and success in mastering applied skills.

Physical exercises with cadets at the first stages of training should be directed, first of all, to the development of speed-strength qualities and general endurance, since they ensure the implementation of special standards by cadets. With the increase in professional training of cadets-artillery scouts in the content of physical training, the leading place should be occupied by exercises for the development of high-speed and special endurance. Also, attention should be paid to technical and topographic preparation, which is confirmed by the research data.

The structure of physical and applied training of cadets with the growth of their professional readiness undergoes significant changes. The leading factor in the physical preparedness of cadets in sports orientation is special technical preparedness, the contribution of which increases to 25.7%. This factor combines not only the characteristics of technical preparedness, but also the results of the running part of the exercise. Such a change in the structure of the preparedness of military artillery scouts is a consequence of the process of physical improvement, reflecting the specifics of the adaptation of their body to the conditions of specific activities. And the specificity is the more significant, the higher the level of professional qualification.

The above-described features of the development of physical qualities and the formation of military-applied motor skills determine the external mechanism of long-term adaptation of the body of artillery scouts in the process of their physical improvement. This mechanism reveals the nature and direction of the relationship between physical qualities and motor skills and allows to identify three main stages of physical improvement of artillery scouts.

At the first stage, artillerymen who do not yet have sufficient experience and practice develop motor skills in performing orienteering exercises, developing strength, speed, speed-strength qualities and general endurance; there are more reliable relationships between the level of development of physical qualities according to the results of orienteering exercises.

The second stage is characterized by consolidation and, further improvement of technical actions, gradual optimization of indicators of high-speed and high-speed endurance.

At the third stage, cadets-artillery scouts of higher qualification utilize the available physical capabilities in order to achieve high results and maintain the optimal level of their development, increase physical and technical skills, and also increase the level of special endurance.

The conducted research gives grounds to recommend including orienteering exercises, which are most identical to actions during combat training, in the system of physical training of cadets for its improvement.

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