The Open Sports Sciences Journal
DOI: 10.2174/011875399X311131240625093447, 2024, 17, e1875399X311131
ISSN: 1875-399X
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RESEARCH ARTICLE OPEN ACCESS

Effectiveness of the Methodology for the Development of Cadets' Motor and Military-applied Skills during Orienteering Training Sessions: A Case-Control Study

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Abstract:

Introduction: The current conditions of warfare and the level of development of military equipment and tactics require high-quality professional training of military personnel. This requires a high level of development of motor and military applied skills of cadets. Orienteering is the most effective means of developing motor and military-applied motor skills in cadets that contribute to the formation of their psychophysical readiness for future professional and combat activities. The aim of the research is to substantiate the methodology for the development of motor skills, and the formation of military applied skills in cadets during their orienteering training sessions and to test its effectiveness.

Methods: The research, which was conducted in 2018-2023, involved 80 male cadets of the S. P. Koroliov Zhytomyr Military Institute (Ukraine), aged 17 to 23. The study's design was a case-control study. To test the methodology of the author, the experimental (EG, n = 40) and control (CG, n = 40) groups were formed from the cadets who entered the institute in 2019 with significantly the same indicators of the development of motor skills, physical condition, health and mental cognitive processes ($p > 0.05$). EG was formed from the cadets who were engaged in orienteering training sessions during the sporting and mass participation activities (3 times per week for 1.5 hours). CG cadets were not engaged in sports, but they practiced sporting and mass participation activities according to the traditional method of physical training. The research methods included analysis of scientific, educational, and methodological literature, internet data and best practices, testing, pedagogical experiments, and methods of mathematical statistics. The level of cadets' motor skills development was assessed by physical training tests, the level of military applied skills formedness in orienteering was assessed by the standards of military topography, and the dynamics of mental cognitive processes was assessed by psychodiagnostic methods. The reliability of the difference between the indicators was determined by the Student's t-test.

Results: The methodology for the development of motor skills and the formation of military-applied skills in cadets during their orienteering training sessions has been worked out and substantiated. Further, it aims to form the psychophysical readiness of cadets for their future professional and combat activities. The methodology has been implemented in four stages: basic, preparatory, main, and military applied, which are characterized by a scientifically sound ratio of theoretical, general, special, and applied physical training. A significantly better ($p \leq 0.05$-0.001) level

of development of general and special motor skills in the EG cadets compared to the CG was revealed by the results of 10 x 10 m shuttle run, 3 km run, obstacle course exercise, 6 x 100 m shuttle run, 3 km run with obstacles, and 10 km accelerated march. The EG cadets showed significantly ($p \leq 0.001$) better indicators than the CG cadets in determining direction (azimuth) afield, transferring targets from the terrain scheme to the map (aerial photo), and passing the 50 m orienteering distance with 5 control points. The EG cadets showed a significantly better ($p \leq 0.05$-0.001) level of indicators of stability and concentration of attention, short-term memory, peculiarities of thinking, and intellectual working capacity than the CG at the end of the experiment.

Conclusion: Testing the methodology for the development of motor skills and the formation of military-applied skills in cadets during their orienteering training sessions confirmed its effectiveness in shaping the psychophysical readiness of cadets for their future professional and combat activities. Assessment of the developed methodology showed its more pronounced positive effects, compared to the traditional method of physical training, in terms of the development of motor skills in cadets, formation of military applied skills in terrain orienteering, and improvement of mental cognitive processes.

Keywords: Physical training, Motor skills, Military, Applied skills, Orienteering, Cadets.

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Cite as: Prontenko K, Okhrimenko I, Bloshchynskyi I, Serednytska I, Chornous V, Tytovych A, Masol V, Zakopailo S, Kryvenko Y. Effectiveness of the Methodology for the Development of Cadets' Motor and Military-applied Skills during Orienteering Training Sessions: A Case-Control Study. Open Sports Sci J, 2024; 17: e1875399X311131.
http://dx.doi.org/10.2174/011875399X311131240625093447

Received: March 14, 2024
Revised: May 24, 2024
Accepted: June 04, 2024
Published: July 05, 2024

1. INTRODUCTION

Physical training is one of the main subject areas of combat training of servicemen, an important and integral element of the combat readiness of military units and subunits to perform assigned tasks [1-8]. Physical training aims to ensure the psychophysical readiness of servicemen for combat activities and the performance of assigned tasks and to facilitate the solution of other tasks of their military education and training [9-19].

The current conditions of warfare in Ukraine and the level of development of military equipment and tactics require high-quality professional training of military personnel [20-26]. This, in turn, requires a high level of development of the motor skills of servicemen, the formation of various military applied skills, including terrain orientation, professionally important psychological qualities, optimal level of physical development, and functional state of the body [27-35]. In addition, the need to prepare servicemen to avoid ambushes and "entrapments" requires the search for an effective means of physical training that will be of practical importance for long-term marches on foot, practicing a surprise attack, landing on and off military vehicles with weapons and equipment, throwing grenades for range and accuracy, accelerated movement in a hypothetically dangerous area that could be attacked by enemy fire, and orientation on the ground using only a topographic map, compass, and natural landmarks [36-39].

The results of research by many scientists [40-46] show that military-applied sports are effective means of physical training of servicemen in higher military educational institutions (HMEIs), which, on the one hand, provide a high overall level of physical fitness, and on the other hand, form military applied skills that are necessary for modern combat. Considering the current conditions of combat operations in Ukraine, orienteering can be the most effective means of forming military-applied motor skills in cadets of HMEIs, as well as developing their motor skills that contribute to the formation of their psychophysical readiness for future professional and combat activities. The ability of future officers to make quick decisions against the background of extreme physical exertion, to accurately navigate in unfamiliar terrain, to move skilfully in difficult conditions, and to overcome artificial and natural obstacles is effectively formed in the process of orienteering [47-52].

The experience of combat operations conducted on the territory of Ukraine in 2014-2024 shows that the encirclement of Ukrainian units near Ilovaisk, Debaltseve, Mariupol, and other settlements was not crowned with success by Ukrainian troops due to insufficient intelligence information about the enemy, the lack of means of communication between units, which made it impossible to coordinate actions and interact with each other, the insufficient level of skills of unit commanders in terrain orientation and other factors. These factors led to a delay in the liberation of the cities and, ultimately, to numerous casualties, capture, and defeat in battle. So, terrain orienteering skills are important and necessary for

every serviceman, from a unit commander to an assault soldier, as mastery of terrain orienteering skills significantly increases the combat capability of the troops as a whole [53-56].

Orienteering is a modern military-applied sport that is included in the combat training programs of the armed forces of most NATO countries [57-61]. Orienteering training contributes to the development of endurance, speed, coordination abilities, and formation of military-applied skills in accelerated movement over rough terrain; orienteering with the help of a map, compass, and natural landmarks (without the use of modern electronic means that disguise the location), contributes to the development of volitional and moral qualities and improves the dynamics of mental cognitive processes and mental working capacity of those involved in it [62-69]. Orienteering is also used as a means of physical and psychological rehabilitation of participants in military operations [70-73]. At the same time, the issue of developing motor skills and forming military-applied skills in cadets during their orienteering training sessions in the process of studying in HMEIs to form their psychophysical readiness to perform assigned tasks during their future professional and combat activities has not been studied enough in recent references. The biggest gaps in the research of scientists remain the impact of orienteering classes on the dynamics of mental cognitive processes of military personnel, on the level of their abilities to quickly make important and responsible decisions in conditions of time shortage and extreme physical and psychological loads, on the peculiarities of the dynamics of mental capacity, and on the level of their readiness to perform combat tasks during the war. The results of our research might have clinical significance for the researchers, clinicians, and patients.

1.1. The Hypothesis of the Research

It is assumed that the substantiation of the author's methodology for the development of motor skills and the formation of military applied skills in cadets during their orienteering training sessions and its implementation in physical education of HMEIs will contribute to a more effective method, compared to the traditional methods of conducting sporting and mass participation events, increase the level of general and special physical fitness of cadets, as well as the formation of their skills in orienteering in unfamiliar terrain, which will ensure the formation of psychophysical readiness of cadets for the effective performance of tasks during their future professional and combat activities.

Hence, this research aims to substantiate the methodology for the development of motor skills and the formation of military-applied skills in cadets during their orienteering training sessions and to test its effectiveness.

2. MATERIALS AND METHODS

2.1. Participants

The research, which was organized in 2018-2023, involved 80 male cadets of the S. P. Koroliov Zhytomyr Military Institute (Ukraine), the Faculty of Technical Intelligence, aged 17 to 23, who were obtaining a bachelor's degree. The study's design was a case-control study. To test the author's methodology, the experimental (EG, n = 40) and control (CG, n = 40) groups were formed from among the cadets who entered the HMEI in 2019 with significantly the same indicators of the development of motor skills, physical condition, health and mental cognitive processes ($p > 0.05$). EG was formed from the cadets who were engaged in orienteering training sessions during the sporting and mass participation activities (3 times per week for 1.5 hours). CG cadets were not engaged in sports, but they practiced sporting and mass participation activities according to the traditional method of physical training (3 times per week for 1.5 hours). There was no special selection for EG and CG. EG cadets independently expressed their desire to engage in sports orientation during their studies. The state of health (physical and mental) of the cadets was assessed in the medical department of the institute, and all cadets were admitted to classes. The level of physical fitness, the level of cognitive processes, and the character of the cadets were not taken into account during the selection. The main selection criterion was the desire of the cadets to engage in orienteering. The conditions of training at the HMEI, as well as the logistical, financial, scientific, methodological, informational, medical, and legal support of the EG and the CG cadets in the educational process, were identical. During the study, the number of EG and CG cadets did not change.

2.2. Procedure

The research was conducted in three stages, which are as follows:

The first stage (2018-2019) involved a search, analysis, and synthesis of scientific and methodological literature, Internet sources, and best practices on the research topic. At the same stage, based on the studies, we substantiated the methodology for the development of motor skills, and the formation of military applied skills in cadets during their orienteering training sessions during their study at the HMEI.

The second stage (2019-2023) provided for the conduct of the pedagogical experiment, which involved the introduction of the methodology for the development of motor skills and the formation of military applied skills in cadets during their orienteering training sessions of physical training in the HMEI (during hours of sporting and mass participation events) and testing its effectiveness. Training sessions during the hours of sporting and mass participation activities were held 3 times a week in the afternoon. Each training session lasted 1.5 hours. EG was formed from the 1st year cadets (2019 enrollment) at their request by interviewing them to determine their interest in practicing the sports available in the HMEI during the hours of sporting and mass participation activities. Training sessions in EG were conducted under the guidance of a sports orienteering coach. CG included cadets of the same training year (year

of enrollment) as those in EG. The CG cadets did not engage in sports during their training in the HMEI. They practiced sporting and mass participation activities according to the traditional method of conducting training sessions, which included 3 training sessions per week according to the approved options: Option 1 – improvement of short and middle distance running (100 m, 200 m, 400 m) and gymnastic exercises (on a gymnastic apparatus); Option 2 – improvement of long-distance running (1 km, 2 km, 3 km, 5 km) and strength exercises (exercises with weights); Option 3 – test training session (testing exercises studied by cadets in the current semester in the academic subject area referred to as "Physical Training"). In CG, training sessions during the hours of sporting and mass participation activities were conducted under the supervision of the commander of the training course or the sports organizer of the unit. In addition to sporting and mass participation activities, all other forms of physical training (training sessions, morning physical exercises, physical training during training and combat activities, and independent training) of cadets of EG and CG, as well as the methodology of their conduct, did not differ from each other. The total number of hours of physical training per week for cadets of EG and CG was the same. The initial level of studied indicators of EG and CG cadets in the 1st training year did not differ significantly ($p>0.05$). The duration of the experiment was 4 years (beginning – September 2019, end – May 2023).

The third stage (2023) included the final processing, analysis, and generalization of the research results, determining the reliability of the difference between the results of the EG and the CG cadets, and drawing conclusions.

2.3. Methods

The following methods were used during the research:

The theoretical method was used for the analysis of scientific, educational, and methodological literature, internet data, and best practices to clarify the current state of the problem under research, systematize and summarize information on the topic of research, and justify the author's methodology. Forty-six sources on the topic of the article from the scientometric databases of Scopus, Web of Science Core Collection, and others were analysed.

The empirical method was used for pedagogical testing and pedagogical experiments to study the impact of orienteering training sessions according to the author's methodology on the development of motor skills (general and special), military applied skills, and the dynamics of cadets' mental cognitive processes;

The methods of mathematical statistics were used for assessing the reliability of the difference between the studied indicators, correct processing of the results, and proving the effectiveness of the developed methodology.

The level and dynamics of the development of general motor skills in cadets were assessed by the following tests: 10 x 10 m shuttle run (speed quality); hip-swing-up to the crossbar (strength quality); 3 km run (endurance); and overcoming the obstacle course (coordination abilities).

The level and dynamics of the development of special motor skills in cadets were assessed by the following tests: 6 x 100 m shuttle run with a submachine gun, throwing an F-1 grenade (600 g) at a distance, 3 km run with obstacles, and 10 km accelerated march.

The level and dynamics of cadets' military applied skills formedness in terrain orienteering were carried out according to the following standards of military topography: determining directions (azimuths) afield, transferring targets from the terrain scheme to the map (aerial photograph), and passing the 50 m orienteering distance with 5 control points (CPs) (spatial orienteering skills were assessed).

The level and dynamics of the cadets' mental cognitive processes were assessed by the following indicators: stability and concentration of attention ("Tangled Lines" method), short-term memory (Jacobson's method), thinking peculiarities ("Identification of Essential Features" method), and intellectual working capacity (Anfimov's method).

All studied indicators were evaluated at the beginning (September 2019) and the end (May 2023) of the experiment. All tests that were used to test EG and CG cadets met the criteria of validity and reliability. Thus, the tests for assessing general and special motor skills in cadets were used from the Order of the Ministry of Defense of Ukraine dated August 21, 2021, No. 225 "On the approval of the Instructions for physical training in the system of the Ministry of Defense of Ukraine" (https://zakon.rada.gov. ua/laws/show/z1289-21#Text); the level of formation of military applied skills among cadets in terrain orientation was carried out according to the norms of military topography, determined by the Combat Training Program of the Ground Forces of the Armed Forces of Ukraine (Handbook of military topography: editorial and publishing center of the Armed Forces of Ukraine. Kyiv: VIKNU named after T. Shevchenko, 2016. 119 p. (https://nuczu.edu.ua/images/topmenu/kafedry/ kafedra-viiskovoi-pidhotovky/distant-content/Topografiy.pdf)); level and dynamics of the cadets' mental cognitive processes were assessed in accordance with the methods specified in the Collection of methods for diagnosing negative mental states of servicemen (Methodical manual. Kyiv: NDC of the Armed Forces of Ukraine, 2016. 234 p. (https://lib.iitta.gov.ua/107163/1/%D0%9F%D0%BE%D1%81%D1%96%D0%B1%D0%BD%D0%B8%D0%BA%20%D0%9D%D0%9F%D0%A1_16.pdf)).

2.4. Statistical Methods

Mathematical and statistical methods were used to process the experimental data obtained. The compliance of the sample data distribution with the Gauss' law was assessed using the Shapiro-Wilk W test. The reliability of the difference between the indicators was determined using the Student's t-test. The results were presented as $M \pm m$, where M is the arithmetic mean, and m is the error

of the arithmetic mean. The reliability of the difference for all statistical tests was set at $p<0.05$. All statistical analyses were performed using the STATISTICA 6.1 software package (number AGAR909E415822FA), adapted for medical and biological research [74].

3. RESULTS

The experience of modern combat operations on the territory of Ukraine has shown that skills in terrain orientation are professionally important and necessary for every serviceman of the Armed Forces of Ukraine. It has also been found that military-applied skills in orienteering in unfamiliar terrain and the ability to make quick, informed decisions against the background of heavy physical and mental stress are effectively formed during orienteering training sessions. All of this necessitates the introduction of orienteering into the physical education of cadets in HMEIs. Therefore, taking into account the above, we have substantiated and developed the author's methodology for the development of motor skills and the formation of military-applied skills in cadets during their orienteering training sessions.

This methodology aims to form cadets' psychophysical readiness for their future professional and combat activities during orienteering training sessions while studying at an HMEI. The main tasks of the methodology are the development of motor skills in cadets (improvement of their general and special physical fitness), formation of military applied skills in orienteering in unfamiliar terrain, and skills of quick decision-making against the background of extreme physical and mental stress, improvement of the dynamics of mental cognitive processes and intellectual working capacity of cadets, and cohesiveness (unification) of military units (teams).

The means used according to the presented methodology include:

-The means of general physical training (GPT) (physical exercises that contribute to the development of general motor skills, improvement of physical development and health, and general working capacity of cadets), exercises for the development of speed quality (30, 60, 100 m run; 10 x 10 m shuttle run, running with acceleration, relay-race, special running exercises, jumping rope, *etc*.), exercises on development of strength qualities (pull-ups, hip-swing-ups, vertical pull-ups with bent arms to support, crossbar abdominal raises; push-ups on parallel bars, floor push-ups; abdominal raises; squats, jumps, outleaps; exercises with weights (with a barbell, dumbbells, kettlebells), exercises with weight of a partner (in pairs), exercises on simulators, *etc*.), exercises for development of endurance (1, 2, 3, 5, 10 km run, running uphill, downhill running on unstable ground (soft ground, sand, *etc*.), movement on skis for 2, 3, 5, 10 km, free style swimming for 200, 400, 600, 800 m), exercises for development of coordination abilities (complex exercise on agility; general control exercise on an obstacle course; 4 x 9 m shuttle run; relay-races, sports games, *etc*.), and flexibility exercises (exercises to stretch muscles and increase mobility of joints and spine);

–The means of special physical training (SPT) (physical and military applied exercises, techniques, and actions that contribute to the development of special motor skills and the formation of various military applied skills), 5-10 km cross-country races, 5-10 km accelerated march in full gear, overcoming natural and artificial obstacles, individually and as part of units, overcoming psychological and special obstacle courses, swimming in full gear (in uniform with weapons), 3 km run with obstacles, 1100 m run with overcoming an obstacle course as part of a unit, 6 x 100 m shuttle run, throwing grenades at a distance and accuracy from a place and during movement, from behind shelters, assisting the wounded and his or her evacuation (transfer), fulfillment of physical training standards, practical shooting from various types of weapons, and movement in small groups, *etc*.;

– The means of orienteering or applied physical training (APT) (physical exercises, tactical and technical actions that contribute to the formation of orienteering skills, improvement of motor and intellectual activities during orienteering, quick adoption of alternative decisions in conditions of time pressure; drawing up tactical options for overcoming distances, *etc*.), orienteering in different types of terrain, orienteering with and without a map, orienteering in the daytime and at night, in different climatic and geographical conditions, skiing orienteering, orienteering in water, running different lengths and complexity of segments with elements of orienteering, exercises for the development of attention, memory, thinking (to find the same pictures or differences in pictures, finding the same marks on maps or differences in maps, exercises on different counting tables, tables of tangled lines, mazes, memorizing and sketching different elements without time limit (with time limit), adding cut maps together without time limit or for speed, *etc*.), combined exercises (for senior cadets) – 5 km accelerated march in full gear with orienteering elements with a map (without a map), 3 km run with obstacles with orienteering elements with a map (without a map), 5 km run with overcoming natural obstacles, grenade throwing and with orienteering elements with a map (without a map), 10 km cross-country race with overcoming water obstacles with and without orienteering elements with or without a map, 10 km accelerated march as part of a unit (small group) in full gear with simulation of ambush, encirclement, "entrapment", with practical (simulated) shooting and providing first aid to one or two wounded and their evacuation and with orienteering elements with or without a map; *etc*.

– The means of theoretical training (TT) (theoretical knowledge, organizational and methodological skills that contribute to the formation of special knowledge in orienteering, military, topography, and physical education).

The methodology has been realized during four stages: basic (the period of cadets' training in the 1st year), preparatory (2nd year), main (3rd year), and military applied (4th year), which are characterized by a scientifically sound ratio of theoretical, general, special, and applied physical training (Table **1**).

Table 1. Ratio of methodological means for the development of cadets' motor quality in the process of orienteering (%).

Means	Stages of the Methodology Implementation			
	Basic	Preparatory	Main	Military Applied
TT	30	15	5	-
GPT	50	45	30	15
SPT	10	20	30	40
APT	10	20	35	45

The tasks of the basic stage of the author's methodology are as follows: bringing the theoretical foundations of orienteering and military topography, following the topics defined in the basic stage; promoting health and harmonious development of all systems and functions of the cadets' body; comprehensive general physical training and initial development of special motor skills; mastering the basic elements of tactical and technical actions in orienteering; developing skills to feel and differentiate the parameters of motor actions; instilling interest and the need for orienteering, and raising discipline and diligence.

The tasks of the preparatory stage of the author's methodology are the acquisition of knowledge by cadets on theoretical foundations following the topics defined in the preparatory stage, further promotion of cadets' health, and improvement of their physical condition (improvement of functional capabilities of the body), including general physical training; increase in the volume of special physical training (application of exercises aimed at forming various military applied skills); improvement of tactical and technical actions on orienteering; improvement of the dynamics of mental and cognitive processes; development of moral and volitional qualities, and participation in physical fitness competitions and the simplest actions in orienteering among cadets of the same age.

The tasks of the main stage of the methodology include: mastering by cadets of theoretical foundations in accordance with the topics defined in the main stage; maintaining the level of development of general motor skills; further improving the morphological and functional state of cadets; in-depth mastering of special physical training exercises aimed at forming various military applied skills; increasing the volume of applied physical training, which involves further improvement of tactical and technical actions in terrain orienteering (in complicated conditions and in combination with the performance of SPT exercises) to develop military applied skills in navigating unfamiliar terrain and making quick, informed decisions against the background of extreme physical and mental stress; improving mental and cognitive processes (memory, attention, thinking); educating moral and volitional qualities and improvement of cadets' mental resistance to high physical and mental stress; and increasing the volume of competitive activities.

Among the tasks of the military applied stage of the methodology are maintaining the level of development of general motor skills, physical condition, and health of cadets; further mastering special physical training exercises aimed at forming various military applied skills; increasing the volume of applied physical training, which involves combining the means of SPT and APT in difficult conditions close to future professional and combat activities, conducting complex training sessions to improve military applied skills in orienteering in unfamiliar terrain and quick decision-making against the background of extreme physical and mental stress; improving technical and tactical skills of cadets in orienteering; in-depth improvement of mental and cognitive processes (memory, attention, thinking); cohesiveness (unification) of a team (group, military unit); and further increasing the volume of competitive activities, judicial and methodological practice.

The dosage of physical load according to the developed methodology was carried out, taking into account the stage of its implementation, the tasks of preparation, content, duration, and intensity of a training session, and the level of cadets' fitness. The physical load of a particular training session was dosed by the total number of exercises in the session, the number of their repetitions, the duration of exercises and rest intervals between exercises (series), the content of rest intervals (active, passive), the amount of effort, the length of the distance, the pace of exercises, their intensity, and the technical complexity of exercises.

The development of general endurance began with the performance of long-duration exercises (20-30 minutes) using a uniform method with low intensity (heart rate – 120-140 beats/min). Gradually, the duration of the exercise was reduced, and the intensity was increased. The optimal heart rate for the development of general endurance was 120-130 – 170-180 beats/min. If the duration of running was reduced to 30-60 minutes, the intensity was increased to a heart rate of 160-180 beats/min. For this purpose, running, cross-country, skiing, and swimming were used. The variable method is also effective for the development of general endurance in orienteering (for example, the pace and, accordingly, heart rate on each km were regulated during a 10 km run: even km – heart rate 140-150 beats/min, odd – 160-170 beats/min). Interval and repeated methods were used to develop high-speed endurance. The duration of running was 10-20 s with an intensity of 90-95% of the maximum speed. We performed 4 approaches in 2-3 series. The rest between sets had an extreme heart rate of 110-120 beats/min, and between series, the full heart rate was 90

beats/min. If the duration of the exercise increased to 40-60 s, the intensity of running decreased to 75-85%. The number of approaches was 3-5, the number of series – was 2-3, and the mode of rest was extreme. We used different strength exercises (with the weight of our own body, with additional weight) to develop strength endurance, observing certain rules: the weight of a load was 30-70% off the individual maximum in a certain exercise, the number of repetitions was from 15-20 and more; the duration of an exercise was 15-120 s, the performance included 2-4 approaches with active rest, and heart rate was 100-120 beats/min. In exercises with the weight of one's own body (on the crossbars, parallel bars, *etc*.), 2-4 series of 4-6 sets in each were performed, but with the less number of times. One of the most effective methods used to develop cadets' strength and endurance was the circle method. A certain methodology was used to develop speed quality (quickness of reaction, quickness of execution of one movement, quickness (frequency, tempo) of movements). The choice reaction was a determining component of high-speed quality in orienteering. To develop the speed of choice reaction, we were guided by the pedagogical principle referred to as "from simple to complex"; that is, we gradually increased the number of possible changes in circumstances and the time deficit for making a decision and performing a response action. The speed of technical and tactical actions was also gradually increased from slow to maximum. Sports and outdoor games and relay races were effective means of developing the speed of complex reactions. During the choice of means of development of quickness of cyclic movements, it was taken into account that quickness has a limited transfer from one exercise to another; therefore, the main means of development of quickness in sport orienteering is a cyclic exercise in which it is necessary to improve quickness, for instance, running. That is why we used running for short distances of 60, 100, and 200 meters. The intensity of short-distance running was 70-100% of the maximum possible speed, and the duration of the exercises was such that you could perform the exercise at maximum speed (5-6 s – 12-15 s). The number of approaches was 2-4, and the number of series was 2- 3. The rest between approaches was extreme to restore heart rate to 110-120 beats/min, and between series – to full restoration of heart rate (90-100 beats/min). To improve the ability to navigate in space, important attention was paid to the training of voluntary attention, which is the ability to select from a variety of stimuli exactly those that are important for orientation in a particular situation. The cadets' memory, attention span, mobility, and concentration, as well as dexterity, were developed through the use of special psychological exercises (tests, techniques, tasks) and in the process of performing various physical exercises (sports games, relay races, actions on signals, various types of orienteering and other exercises). Spatial orientation skills were improved while performing tasks in difficult conditions, with a lack of space or time, insufficient information, an uncorrected map, or inconveniently placed control points.

Moreover, to develop spatial orientation, we used jumps, turns by a given number of degrees, moving a given distance with eyes closed, running or swimming certain distances for a given time, *etc*. Visual short-term memory was developed through the following exercises: running segments of different lengths, with different numbers of control points, at different speeds, and with the terrain navigation memory. To develop flexibility, exercises were used to stretch muscles and increase joint mobility.

The methods used to teach and train cadets, according to the author's methodology, included teaching methods (verbal, visual, practical) and training methods (uniform, variable, repetitive, interval, circular, game, and competitive).

The pedagogical experiment was organized at S. P. Koroliov Zhytomyr Military Institute to test the effectiveness of the author's methodology. As it has already been determined, the level of development of general motor skills in cadets was assessed by the following tests: 10 x 10 m shuttle run, hip-swing-up on the crossbar, 3 km run, and overcoming the obstacle course. It was found that at the beginning of the experiment, there was no significant difference in all studied indicators between the EG and the CG cadets ($p > 0.05$) (Table **2**). During the experiment on all motor qualities, the cadets of both groups showed a significant improvement in results ($p \leq 0.001$), which testifies to the effectiveness of the training sessions both by the existing (traditional) method of physical training in HMEIs and by the author's methodology. The level of development of all studied qualities, except endurance, at the end of the experiment, was estimated as "excellent" and the level of endurance development was estimated as "good". At the same time, at the end of the experiment, the EG cadets showed significantly better indicators, compared to the CG, in a 10 x 10 m shuttle run – by 0.33 s ($p \leq 0.05$), in the 3 km run – by 62.1 s ($p \leq 0.001$) and in overcoming an obstacle course – by 8.9 s ($p \leq 0.001$). The EG cadets also showed better indicators of strength quality judging from the hip swing-ups than in the CG by 0.7 times at the end of the experiment, but no significant difference was found between them ($p > 0.05$).

The level of development of special motor quality in the EG and CG cadets was evaluated by the following tests: 6 x 100 m shuttle run with a submachine gun, throwing an F-1 grenade (600 g) at a distance, 3 km run with obstacles, and 10 km accelerated march. There was no significant difference in all studied indicators between the EG and the CG cadets ($p > 0.05$) at the beginning of the research (Table **3**). During the experiment, the EG and the CG cadets showed a significant improvement in all studied tests ($p \leq 0.001$), which also allows us to assert the effectiveness of the training sessions both according to the existing method of physical education in HMEIs and the author's methodology.

However, at the end of the experiment, the EG cadets showed significantly better indicators compared to the CG in the 6 x 100 m shuttle run by 8.2 s ($p \leq 0.001$), in the 3 km run with obstacles – by 39.1 s ($p \leq 0.001$) and in the 10

km accelerated march – by 74.9 s ($p \leq 0.01$). The results of the EG and CG cadets did not differ significantly ($p > 0.05$) in an F-1 grenade thrown at a distance. This indicates that the training sessions conducted according to the author's methodology have a more positive effect on the development of general and special motor skills in cadets and the formation of their military applied skills in accelerated movement over rough terrain as part of a unit and over long distances, throwing grenades at a distance and overcoming natural and artificial obstacles, which are necessary for future professional and combat activities.

Table 2. Level and dynamics of development of general motor skills in the EG and CG cadets during the pedagogical experiment (n = 80).

Stages of the Experiment	EG (n=40)	CG (n=40)	Reliability of the Difference
10 x 10 m shuttle run, s			
Beginning	27.01±0.12	27.09±0.13	t =0.45; p>0.05
End	25.91±0.10	26.24±0.11	t =2.22; p≤0.05
Hip-swing-up on the crossbar, times			
Beginning	5.4±0.49	5.6±0.43	t =0.31; p>0.05
End	11.8±0.55	11.1±0.52	t =0.92; p>0.05
3 km run, s			
Beginning	752.4±5.33	761.5±5.21	t =1.22; p>0.05
End	663.5±5.16	725.6±5.12	t =8.54; p≤0.001
Overcoming the obstacle course, s			
Beginning	141.5±1.48	145.3±1.62	t =1.73; p>0.05
End	115.7±1.37	124.6±1.54	t =4.32; p≤0.001

Note: Legend: t - Student's t-test value; p – the significance of the difference between the indicators of EG and CG.

Table 3. Level and dynamics of development of special motor skills in the EG and CG cadets during the pedagogical experiment (n = 80).

Stages of the Experiment	EG (n=40)	CG (n=40)	Reliability of the Difference
6 x 100 m shuttle run with a sub-machine gun, s			
Beginning	157.3±1.37	158.2±1.52	t =0.41; p>0.05
End	119.4±1.29	127.6±1.46	t =4.21; p≤0.001
Throwing an F-1 grenade (600 g) at a distance, m			
Beginning	29.5±0.97	29.9±0.99	t =0.29; p>0.05
End	38.2±0.84	37.7±0.92	t =0.40; p>0.05
3 km run with obstacles, s			
Beginning	918.2±5.68	926.6±5.76	t =1.04; p>0.05
End	803.3±5.52	842.4±5.59	t =4.98; p≤0.001
10 km accelerated march, s			
Beginning	3446.6±18.54	3461.8±19.05	t =0.56; p>0.05
End	3206.7±16.27	3281.6±18.49	t =3.04; p≤0.01

Note: Legend: t - Student's t-test value; p – the significance of the difference between the indicators of EG and CG.

Table 4. Level and dynamics of military applied skills formedness in the EG and CG cadets during the pedagogical experiment (n = 80).

Stages of the Experiment	EG (n=40)	CG (n=40)	Reliability of the Difference
Determining Direction (azimuth) Afield, s			
Beginning	53.11±1.54	54.82±1.64	t =0.76; p>0.05
End	40.03±1.39	47.61±1.58	t =3.60; p≤0.001
Transferring targets from the terrain scheme to the map (aerial photograph), s			
Beginning	318.31±4.62	325.10±4.56	t =1.06; p>0.05
End	267.45±4.37	292.17±4.42	t =3.98; p≤0.001
Passing the 50 m orienteering distance with 5 control points (CPs), s			
Beginning	27.83±0.92	27.94±0.89	t =0.09; p>0.05

(Table 4) contd.....

Stages of the Experiment	EG (n=40)	CG (n=40)	Reliability of the Difference
End	24.72±0.81	27.13±0.83	t =2.08; p≤0.05

Note: Legend: t - Student's t-test value; p – significance of difference between the indicators of EG and CG.

Table 5. Level and dynamics of mental cognitive processes in the EG and CG cadets during the pedagogical experiment (n = 80).

Stages of the Experiment	EG (n=40)	CG (n=40)	Reliability of the Difference
Stability and Concentration of Attention, c. u.			
Beginning	9.37±0.57	10.06±0.53	t =0.89; p>0.05
End	20.82±0.45	17.78±0.49	t =4.57; p≤0.001
Short-term memory, points			
Beginning	5.26±0.21	5.18±0.20	t =0.28; p>0.05
End	8.73±0.16	7.32±0.18	t =5.85; p≤0.001
Thinking peculiarities, points			
Beginning	14.21±0.35	13.94±0.37	t =0.53; p>0.05
End	18.47±0.32	16.52±0.40	t =3.81; p≤0.001
Intellectual working capacity, c. u.			
Beginning	784.6±9.69	769.9±10.07	t =1.05; p>0.05
End	1012.5±9.54	896.1±9.85	t =8.49; p≤0.001

Note: Legend: t - Student's t-test value; p – significance of difference between the indicators of EG and CG.

The results of the assessment of the level of military applied skills formedness in the EG, and the CG cadets in terrain orienteering are presented in Table **4**.

The comparison of all studied indicators in the EG and CG cadets at the beginning of the pedagogical experiment showed no significant difference between them ($p > 0.05$). Moreover, all indicators in the EG were significantly better than in the CG at the end of the experiment. The difference between the indicators of the EG and the CG cadets was 7.58 s ($p \leq 0.001$) in the test on the determination of direction (azimuth) afield,24.72 s ($p \leq 0.001$) in the test on transferring targets from the terrain scheme to the map (aerial photo), and 2.41 s ($p \leq 0.05$) in the test on passing the 50 m orienteering distance with 5 control points. The analysis of the dynamics of these indicators showed their improvement in both groups of cadets during the experiment; however, if all indicators improved significantly ($p \leq 0.05$-0.001) in the EG, in the CG, the indicators of tests on the determination of direction (azimuth) afield and transfer of targets from the scheme of the terrain to the map (aerial photo) had a significant improvement. The indicators of the test on the determination of spatial orientation skills did not change significantly ($p > 0.05$). The analysis reliably confirmed the advantage of orienteering training sessions according to the author's methodology over the existing method of physical training in terms of the formation of military-applied skills in orienteering in unfamiliar terrain. It is also worth emphasizing that the performance of all three tests in military topography required the cadets to demonstrate a certain level of development of intellectual abilities and mental cognitive processes (memory, attention, thinking), which also testifies to the effect of training according to the author's methodology.

The mental cognitive processes of the EG and the CG cadets were evaluated by the following indicators: stability and concentration of attention, volume of short-term memory, peculiarities of thinking, and intellectual working capacity (Table **5**).

It was found that at the beginning of the experiment, all indicators of mental cognitive processes in the EG and the CG cadets did not differ significantly ($p > 0.05$). During the experiment, both groups of cadets showed a significant improvement in the studied indicators ($p \leq 0.001$). However, at the end of the experiment, the EG cadets showed significantly better indicators of stability and concentration of attention – by 3.04 c. u. ($p \leq 0.001$), short-term memory – by 1.41 c. u. ($p \leq 0.001$), thinking – by 1.95 points ($p \leq 0.001$), and intellectual working capacity – by 116.4 c. u. ($p \leq 0.001$). Thus, the conducted analysis showed a more pronounced positive influence of orienteering training sessions according to the author's methodology on the level and dynamics of development of motor skills (general and special), cadets' military applied skills formedness in orienteering in the terrain as well as the dynamics of mental cognitive processes in the EG cadets. A high level of these indicators in the EG cadets will contribute to the effective fulfillment of the tasks of their future professional and combat activities.

4. DISCUSSION

In the process of studying the literary sources [49, 53, 75-79] on the topic of research, we found out that the conditions of modern warfare with the Russian aggressor have their peculiarities (ambush, encirclement, "entrapment", *etc.*) that require a high level of psychophysical readiness for the military personnel of the Armed Forces of Ukraine; the ability to clearly navigate in a difficult situation and in the terrain (read topographic maps, distinguish the sides of the horizon and choose the right

landmarks and routes) to save lives, reduce losses among personnel and military equipment, and ensure the effectiveness of performing assigned tasks. It has been established that to form the psychophysical readiness of cadets for future professional and combat activities, it is effective to introduce modern military-applied sports, in particular, orienteering, into the educational process of physical education in HMEIs [80-83]. It has also been found that orienteering is a modern military-applied sport that is included in the competition program of the International Council of Military Sports, which significantly contributes to its popularity among cadets. Endurance, speed, and coordination abilities are developed in the process of orienteering training sessions, military applied skills in orienteering in unfamiliar terrain are formed, health is strengthened, and the dynamics of mental and cognitive processes are improved [84-89].

Scientists [90-92] argue that during orienteering training, the span of attention increases, and the attention is switched. The problem of the inability to control one's emotions and mood is solved, as the success of athletes of any level in orienteering competitions often depends on this. Orienteering is characterized by the most organic combination of motor and intellectual qualities. It has an extraordinary impact on relieving nervous stress from the human body and is a means of improving health for people of all ages [93, 94]. Orienteering training sessions are especially effective for servicemen whose combat activities require them to have developed motor skills and formed abilities and skills to navigate the terrain, anticipate possible situations, plan their actions, and make the right decisions in conditions of time pressure (in stressful and constantly changing situations), and move quickly on the battlefield by overcoming obstacles [95, 96].

Given the above reasons, we have developed and substantiated the methodology for the development of motor skills. The formation of military-applied skills in cadets during their orienteering training sessions in the process of studying at the HMEI aims to form the psychophysical readiness of cadets for their future professional and combat activities. A key feature of the methodology is the early development of motor skills and the formation of military-applied skills in cadets in orienteering and quick decision-making skills against the background of extreme psychophysical stress through the rational combination of orienteering and special physical training (military-applied exercises) to exclude the possibility of servicemen of the Armed Forces of Ukraine getting into "entrapments" (ambushes, encirclements), preserving their life and health, as well as the quality of their assigned tasks. The organizational and pedagogical conditions for ensuring the effectiveness of the author's methodology include the motivational and value attitude of cadets to orienteering training sessions, the level of development of their motor skills and mental cognitive processes, pedagogical skills and motivation of the coach-instructor to conduct training sessions according to the author's methodology with cadets, and the necessary material and technical support for organizing and conducting training sessions according to the author's methodology in HMEIs. The final result of the author's methodology is the psychophysical readiness of cadets for their future endeavors, which involves a high level of development of their motor skills, the formation of military-applied skills in terrain orientation, and quick decision-making in time-restrained conditions, as well as a high level of their mental cognitive processes. Furthermore, the results of the pedagogical experiment confirmed the formulated hypothesis. The results obtained in this study confirm the conclusions of the work of many scientists [97-103] and expand them further.

CONCLUSION

The methodology for the development of motor skills and the formation of military applied skills in cadets during their orienteering training sessions in the process of studying in an HMEI has been developed and substantiated, which aims to form the psychophysical readiness of cadets for their future professional and combat activities. The methodology was implemented in four stages: basic, preparatory, main, and military applied, which were characterized by a scientifically sound ratio of theoretical, general, special, and applied physical training. The key feature of the author's methodology that distinguished it from existing methods in orienteering was that, for the first time, in order to exclude the possibility of getting the military personnel of the Armed Forces of Ukraine into "entrapments" (ambushes, encirclements, *etc.*), preserving their life and health, as well as the quality of their assigned tasks, we substantiated and developed the methodology, the essence of which is the early development of motor skills and the formation of military applied skills in cadets in orienteering and skills of quick informed decision-making against the background of extreme physical and mental stress by rationally combining orienteering and special physical training (military applied exercises).

Further, the analysis of the effectiveness of the developed methodology showed its more pronounced positive effect, compared to the traditional method of physical training, in terms of the following: improvement of general and special physical fitness of cadets. A significantly better ($p \leq 0.05$-0.001) level of development of general and special motor skills in the EG cadets compared to the CG was revealed at the end of the formative stage of the pedagogical experiment, by the results of 10 x 10 m shuttle run (by 0.33 s), 3 km run (by 62.1 s), obstacle course exercise (by 62.1 s), 6 x 100 m shuttle run (by 8.2 s), 3 km run with obstacles (by 39.1 s), and 10 km accelerated march (by 74.9 s); development of military applied skills in terrain orienteering. The EG cadets showed significantly ($p \leq 0.001$) better indicators than the CG cadets at the end of the experiment in determining direction (azimuth) afield (by 7.58 s), transferring targets from the terrain scheme to the map (aerial photo) (by 24.72 s) and passing the 50 m orienteering distance with 5 control points (by 2.41 s); improvement of mental cognitive processes. The EG

cadets showed a significantly better ($p \leq 0.05$-0.001) level of indicators of stability and concentration of attention (by 3.04 c. u.), short-term memory (by 1.41 c. u.), peculiarities of thinking (by 1.95 points), and intellectual working capacity (by 116.4 c. u.) than the CG at the end of the experiment. In addition, the results of the pedagogical experiment confirmed the formulated hypothesis. Thus, the implementation of the suggested methodology showed its high efficiency in the formation of the psychophysical readiness of cadets for their future professional and combat activities.

RESEARCH LIMITATIONS

The experiment did not take into account the following: the success of the EG and CG cadets in military and professional academic subject areas (Military, Topography, Tactical Training, *etc.*) as well as out-of-training means that could, in some way, affect the results of the research (nutrition, recovery means, *etc.*). However, it was assumed that the conditions of training at the HMEI, as well as the logistical, financial, scientific, methodological, informational, medical, and legal support of the EG and the CG cadets in the educational process, were identical.

PRACTICAL RECOMMENDATIONS

The main theoretical and methodological provisions, as well as the practical results of the research, can be used in the development of programs, work programs, and teaching academic subject areas in HMEIs that train specialists in various military specialties, such as "Physical Training" and "Warrior's Combat Survival Systems"; in the organization of sporting and mass participation events and the work of sports orienteering clubs. The developed methodology can be adapted to the educational process of physical education of cadets of higher educational institutions with specific learning environments, as well as civilian higher educational institutions where students are trained under the reserve officer training program. In the future, it is recommended to investigate the impact of orientation classes on indicators of physical development, functional state, and health of cadets, compared to other military-applied sports (military pentathlon, triathlon, applied swimming, cross-country running, and others) and also to carry out a comparative analysis of the results obtained in our study with the results of the influence of classes in other military sports on the development of movement qualities and military skills of cadets.

PROSPECTS FOR FURTHER RESEARCH

The plan is to introduce the developed methodology to other HMEIs of Ukraine, conduct a comparative analysis of the results obtained, and adapt the author's methodology to rehabilitation programs for combatants.

AUTHORS' CONTRIBUTION

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

APT	=	Applied Physical Training
GTP	=	General Physical Training
TT	=	Theoretical Training

ETHICAL STATEMENT

This research complies with the ethical standards of the Order of the Minister of Defense of Ukraine, «On Approval of the Regulation on the Organization of Scientific and Technical Activity in the Armed Forces of Ukraine,» No. 385, dated 27.07.2016. The procedure for organizing the study, the stages, the venue, and the permission for the involvement of cadets in the research were previously agreed upon with The Committee on Compliance with Academic Integrity and Ethics of the S.P. Koroliov Zhytomyr Military Institute (Protocol No. 12 dated 30.08.2019). Moreover, this research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects.

CONSENT FOR PUBLICATION

Informed consent was received from all cadets who took part in this research.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supporting information are available within the article.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

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