Asesorías y Tutorías para la Investigación Científica en la Educación Puig-Salabarría S.C.
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RFC: ATI120618V12

Revista Dilemas Contemporáneos: Educación, Política y Valores.
http://www.dilemascontemporaneoseducacionpoliticayvalores.com/
Año: VII Número: 2 Artículo no.:47 Período: 1ro de enero al 30 de abril del 2020.

TÍTULO: Características de la metodología del desarrollo de las cualidades físicas de los cadetes durante las actividades de levantamiento de pesas.

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RESUMEN: La metodología de los autores sobre el desarrollo de las cualidades físicas de los cadetes durante las actividades de levantamiento de pesas se confirma en el artículo y se verifica su eficiencia. 86 cadetes participaron en la investigación. Se formaron los grupos experimentales (EG, n=29) y control (CG, n=57). La investigación se realizó de acuerdo con las siguientes pruebas:

carrera de 100 m, carrera de 3 km, inclinación hacia adelante del cuerpo, mantener el cuerpo en posición horizontal, ejercicio de barra de levantamiento, balanceo de cadera, flexión en barras paralelas, ejercicio de poder complejo. Al final del estudio, la mayoría de las pruebas establecieron un nivel significativamente mejor del desarrollo de las cualidades físicas de los cadetes.

PALABRAS CLAVES: cualidades físicas, entrenamiento físico, levantamiento de pesas, cadetes.

TITLE: Features of the methodology of the development of cadets' physical qualities during kettlebell lifting activities.

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ABSTRACT: The authors' methodology of the development of the physical qualities of cadets during kettlebell lifting activities is substantiated in the article and its efficiency is checked. 86 cadets participated in the research. The experimental (EG, n=29) and control (CG, n=57) groups were formed. The research was conducted according to the following tests: 100 m race, 3 km race, forward inclination of the body, holding the body in a horizontal position, pull-up bar exercise, hip-swing-up, push-up on parallel bars, complex power exercise. At the end of the study, a significantly better level of the physical qualities' development of cadets engaged in kettlebell lifting activities according to the authors' methodology was established by the majority of tests.

KEY WORDS: physical qualities, physical training, kettlebell lifting, cadets.

INTRODUCTION.

The scientists (Bolotin, Bakayev, & Vazhenin, 2016; De Castro, Aquino, Berti Junior, Goncalves, & Puggina, 2017; Forghani, Fathi Shob, & Rahimi Aliabadi, 2014; Wernbom, Augustsson, & Thomee, 2007) note the high popularity of power kinds of sport and exercises among youth, and also among the cadets of higher military educational institutions (HMEI). Kettlebell lifting takes the leading place among those kinds of sport and it has a positive influence on the cadets' organism (Borisevich, & Tolstov, 2005; Brumitt, En Gilpin, Brunette, & Meira, 2010; Bolotin, Bakayev, & Vazhenin, 2016; Prontenko, et al., 2017).

In the works of scientists (Ambrozy, et al., 2017; Beauchamp, & Pike, 2006; Kuzmin, 2003; Maulit, et al., 2017) it is proved that power exercises contribute to the improvement of the aesthetic self-improvement due to the proportionality and symmetry of the muscles and the all balanced development of all muscle groups, body correction, including elimination of disadvantages, recovery after injuries, increase of ability to work; the formation of a harmonious figure.

The scientists (Lake, & Lauder, 2012; Manocchia, Spierer, Lufkin, Minichiello, Castro, 2013; Griban, Prontenko, & Prontenko, 2014) point out that power loads have a positive effect on the state of health, ability to work and a range of physical and psychological qualities. The authors (Farrar, Mayhew, & Koch, 2010; Kruszewski, et al., 2017; Kałwa, Stefaniak, Harmacinski, & Groffik, 2019) state that the optimal level of power development is an effective factor in preventing diseases and providing energy-forming functions of the body.

According to the results of scientists' works (Ho-Jin, Yong-Seong, Woon-Soo, Won-Gi, Yong-Beom, & Yong-Nam, 2017; Andreychuk, 2007; Prontenko, et al., 2019), kettlebell lifting has several advantages over other power sports and exercises: low costs; sports equipment compactness; possibility of training both within limited space and in the open area; the opportunity to conduct both self-training and exercises simultaneously with a large group of people; a wide range of simple and available exercises eliminates the possibility of adaptation to the same type of load; possibility to conduct exercises simultaneously with servicemen of different levels of physical fitness, high efficiency in the development of physical qualities and moral-volitional qualities, strengthening the muscles of the back and the whole body; prevention of injury to the spine and joints.

The authors (Vorotyntsev, 2002; Tsatsouline, 2006) think that a large number of exercises with kettlebells is performed with the bending and straightening of the body, that greatly contributes to strengthening the back muscles, shoulder girdle, legs, abdominal press – as a result the formation of a "muscular corset" and prevention of injuries in everyday life, military service, etc. The researches of scientists (Vatel, & Gray, 2005; Tikhonov, Sukhovey, & Leonov, 2009) proved that regular kettlebell lifting training contributes to effective power development, general and power endurance, static endurance of the body muscles, coordination abilities while having a positive effect on the emotional state of those who do this sport.

The substantiation of the modern methodology of the physical qualities' development of cadets of HMEI during kettlebell lifting activities in order to increase their level of physical fitness and improve the efficiency of future professional activity is quite relevant that led to the choice of the research topic.

DEVELOPMENT.

Methodology.

The aim of the work is to substantiate the authors' methodology of the physical qualities' development of cadets of HMEI during kettlebell lifting activities and to check its efficiency experimentally.

The cadets of S. P. Koroliov Zhytomyr Military Institute, aged 18-24, participated in the study (n=86). The duration of the experiment is 5 years (2013-2018). To test the effectiveness of the authors' methodology, the experimental (EG, n=29) and control (CG, n=57) groups were formed. The EG included the cadets who were engaged in kettlebell lifting according to the authors' methodology of physical qualities' development, the CG included the cadets who were engaged in kettlebell lifting too, but according to the traditional program, not taking into account the authors' methodology. The study groups were formed from cadets with statistically equivalent levels of preparedness ($p>0.05$).

The research was conducted according to the following tests: 100 m race (speed), 3 km race (general endurance), forward inclination of the body (flexibility of the back), holding the body in a horizontal position (static endurance of body muscles), pull-up bar exercise (power), hip-swing-up with a pull-up bar (power), push-up on parallel bars (power), complex power exercise (power).

The research methods used were theoretical analysis and generalization of scientific and methodical literature, pedagogical observation, pedagogical experiment, and methods of mathematical statistics.

During the research, the authenticity of the difference between the indicators of cadets by the means of the Student's criterion was determined. The significance for all statistical tests was set at $p<0.05$. The researches related to the involvement of cadets were carried out in compliance with all relevant national regulations and institutional policies (Order of the Minister of Defense of Ukraine "On Approval of the Regulation of the Organization of Scientific, Research and Technology Activities in the Armed Forces of Ukraine" dated 27.07.16, No. 385). The informed agreements were received from all people involved in this research.

Results and discussion.

Concerning the methodology of the physical qualities' development, it should be noted that the leading scientists in the field of physical education and sports (Platonov, 2014; Krutsevych, 2008) identify three main issues, on the successful solution of which depends the efficiency of the learning process: 1) the identification of the leading factors (components) that determine the success in this types of muscular activity the most and the development of the methods of evaluation of the qualities that form one or another factor (component); 2) the substantiation of the means and methods that develop mentioned qualities the most; 3) the rational planning of efficient means and methods in the learning process.

The observations on the training process and competitive activity of the kettlebell-lifters of different qualifications, personal long-term studies, as well as the results of studies of other scientists (Tikhonov, Sukhovey, & Leonov, 2009; Prontenko, et al., 2019) show that, depending on the level of qualification and weight category, the levels of the development of the basic physical qualities of kettlebell-lifters are significantly different. Thus, the level of development of power qualities plays a decisive role in improving the results of the kettlebell-lifters with the athletic titles. This factor is of particular importance for the kettlebell-lifters of lightweight categories.

As the preparedness is increased, the value of strength indicators is decreased, and when a certain level is reached, the power indicators transfer to the category of the supporting components of physical fitness. At the same time, there is a significant increase in the indicators of endurance (both general and special) and flexibility. The percentage of the level of the development of the basic physical qualities of cadets that influence the achievement of high results in kettlebell lifting, depending on their qualification (the 3rd, the 2nd, and the 1st grades, the Candidate Master of Sports (CMS), the Master of Sports (MS), the Master of Sports of International Level (MSIL)), is shown in Fig. 1.

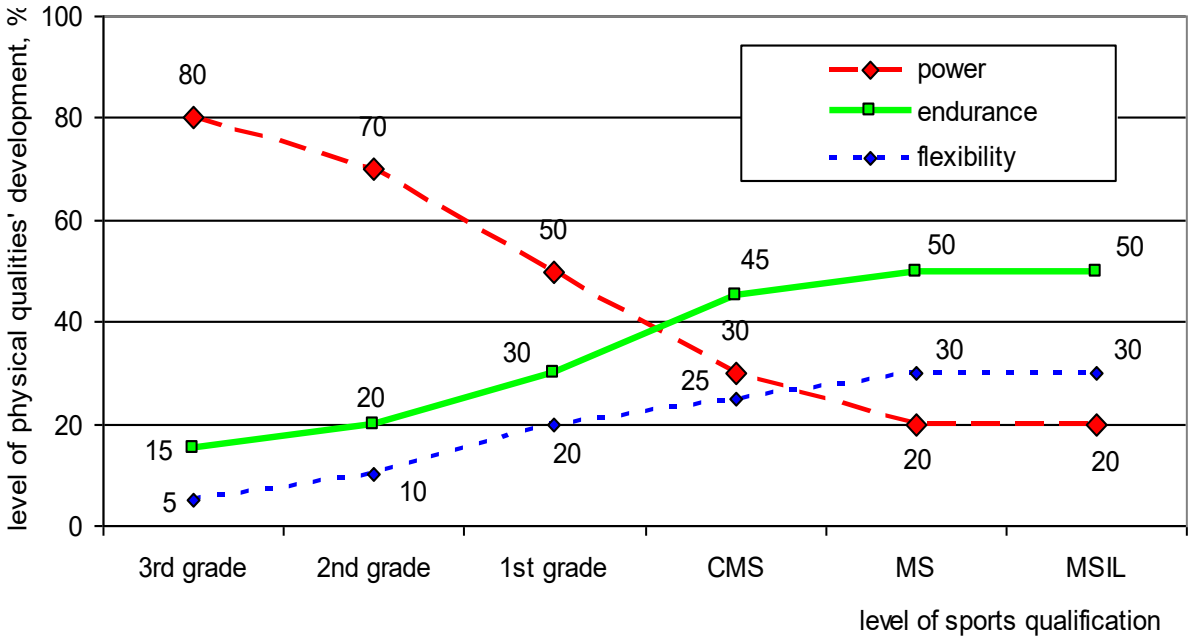

Fig. 1. Ratio of the level of basic physical qualities' development of cadets engaged in kettlebell lifting depending on the level of their sport qualification.

Taking into account the conclusions of scientists and the results of our own research, we developed the authors' methodology of basic physical qualities' development of cadets during kettlebell lifting activities.

Confirming the results of our research, the majority of experts in kettlebell lifting emphasize the importance of priority development of general endurance to achieve high results in kettlebell lifting. The endurance is a complex quality characterized by the ability to perform significant volumes of motor activities, to maintain a high level of activity for a long time, to fight exhaustion and recover during and after exercise efficiently.

An important feature of general endurance is its positive transfer to other types of human activity, to military-professional (combat) activity, in particular. The main factors that determine endurance are muscle structure; intramuscular and intermuscular coordination; cardiovascular and respiratory systems performance; the reserves of energy materials in the organism; the level of development of other physical qualities; technical readiness. Therefore, it is necessary to provide training impact on these factors in the process of developing general endurance that requires solving the following tasks: the development of the capacity of functional systems of aerobic energy supply (the increase in maximum oxygen consumption); the improvement of the capacity of aerobic energy supply source (the development of the ability to perform work at maximum oxygen consumption level for a long time); the development of the mobility of functional aerobic power supply systems (the reduction of time to deploy systems to their maximum capacity); the improvement of functional and technical efficiency; the increase in volume and capacity of buffer systems of an organism (the increase of resistance to transfer the changes in an internal environment of an organism (the accumulation of lactic acid, increase in body temperature, etc.)).

The basic requirements for the means (physical exercises or their complexes) used for endurance development are a relatively simple technique of their performance; an active functioning of the majority of skeletal muscles; an increased activity of functioning of cardiovascular and respiratory systems; the possibility of dosing and regulation of physical activity; the possibility of long performance.

The main principle of the development of general endurance by the authors' methodology was the gradual increase in the duration of moderate-intensity exercises (the method of continuous standardized exercise). It accustoms the body to perform the activity for a long time, improves the condition of the cardiovascular and respiratory systems, and extends the functionality of the whole organism. Then there was an increase in intensity to the optimum level (to the limits of anaerobic metabolism). The intensity of the exercise was determined by the heart rate since it is known that there is a linear dependence between the heart rate (HR) (in the range of 120-130 to 170-180 bpm) and the maximum oxygen consumption (MOC). For example, performing a 20-min exercise with a 60% MOC intensity, the heart rate is about 150 bpm. At the same time, we took into account that the activities that caused an increase in heart rate up to 120-130 bpm did not contribute to the improvement of the functional capacity of an organism and subsequently, the development of endurance, and there was an improvement not of aerobic, but anaerobic systems of an organism with a heart rate of more than 170-180 bpm that contributed to the development not of general, but of special endurance. Also, the method of continuous variational and interval exercise, the essence of which was to change the intensity of the exercise during its long-lasted performance was effective for the development of general endurance.

According to our methodology, this was revealed in 5-10 km running with alternation of acceleration by 100-400 m (HR – 160-170 bpm) and jogging (HR – 120-130 bpm). At the same time, the duration of the intervals of increased intensity (the magnitude of the acceleration intervals) was increased in the training process, and the duration of the intervals of reduced intensity was decreased.

According to the authors' methodology, cyclic sports (running up to 1 hour, cross-country running, running with the acceleration, skiing, working on gym machines, etc.), sports and active games (football, basketball, relay races), jumping exercises (the number of repetitions in the set is more

than 20-30 reps), the exercises with light weights lasting 20-30 minutes, the complexes of exercises according to the system "Crossfit" were applied to develop general endurance.

To develop static endurance, the following exercises were applied: holding the kettlebells on the chest in the initial position and in the position of fixation, holding the body in a horizontal position, holding the angle on parallel bars, plank hold, hangs on the crossbar. It is important to note that the exercises with kettlebells that were used to develop endurance contributed to the improvement of technical preparedness of cadets and the development of other physical qualities (power, flexibility, coordination abilities) on the principle of double impact. In contrast to the methodology of the development of general endurance, we used kettlebell exercises to develop special endurance.

The special endurance in kettlebell lifting is the ability to perform the maximum number of kettlebells lifting exercises during a set period of time at a high rate. The ratio of the volume and intensity of the exercises with kettlebells depended on the stage of preparation and the level of the cadets' readiness. Having reached the planned optimum volume of the activity, the volume was decreased and the intensity continued to increase. The constant change in the ratio of volume and intensity of activities helped to reduce the adaptation (habituation) time of the cadets' organisms to the same activities and to improve the special endurance and results in kettlebell lifting exercises.

The strength as a physical quality is determined by the ability of a person to overcome external resistance or counteract it through muscular effort. The strength is an integral physical quality on which the display of all other physical qualities depends. The scientists (Platonov, 2014; Krutsevych, 2008) conditionally distinguish such types of power as absolute, relative, explosive, high-speed, and power endurance. Regardless of the specificity of power qualities, they are in some way interconnected both in their display and in their development; they are the components of most human motor actions. The less the resistance value to be overcome (the weights) is, and the more endurance dominate, the less the value of maximum power for the efficiency of physical exercise is.

The factors on which human power capabilities depend are external (the resistance value, length of levers, conditions, etc.) and internal (muscle structure; muscle mass; intramuscular and intermuscular coordination; muscle reactivity; the power of energy sources).

It is known that training with a weight of 80-90% of the maximum makes the greatest impact on power improvement. However, neither explosive, nor maximal, nor absolute powers are determined not to be expressed maximally in kettlebell lifting. The muscles of a kettlebell lifter should develop not only great tension but also high speed, while the tension does not exceed 70% of the maximum. A characteristic feature of kettlebell lifting is also the need to exercise power for a long time without reducing efficiency, thus, the requirements for power endurance are increased.

In the initial stage of cadets' training, the development of absolute power is of great importance for further success in kettlebell lifting. The requirements for the development of power qualities are reduced with the development of skills. When the level of MS is reached by a cadet, power exercises with a barbell, body weight and other weights are applied mostly to maintain the level achieved, as well as to strengthen the muscular system in order to prevent injury.

The means of development of power qualities of cadets by the authors' methodology were the following exercises: with the weight of one's own body (on gymnastic equipment, jumping exercises, etc.), with weights (barbell, kettlebells, and weights), on power gym machines. It is important to note that the extensor muscles get the greatest tension, in contrast to slight tension of the flexor muscles, so the main attention was drawn to the muscles of the legs, back, and arms when developing the power of the cadets.

In the initial stage of cadets' training, the exercises (usually with a barbell) with the weight of 70-90% of the maximum (maximum effort method), of 3-6 sets for one group of muscles, 6-12 reps each, lasting for 20-40 sec were applied for the development of maximum power. In the class, the cadets first performed exercises for more massive muscle groups and then for the smaller ones. The

rest between sets was active, it lasted till the recovery of heart rate to 100-110 beats per minute, and during rest flexibility exercises were performed. The circuit-style activities – the alternate performance of exercises for different groups of muscles in several designated training areas with sequential changes are defined to make the greatest effect on the training of cadets. Switching from one muscle group to another helped to reduce rest intervals that increased motor activity. The regulation of activities was carried out taking into account the model characteristics depending on the level of preparedness of a cadet and one's weight category and it was ensured by increased weights, the number of repetitions, the number of sets (circuits), reducing the duration of rest.

To develop power endurance, a repeated effort method, in which the weights accounted for not more than 50-70% of the individual maximum, the number of repetitions in set ranged from 15-20 to 50 reps or more (60-100% of the repeated maximum, the greatest training influence was made by the last raises), the number of sets was 3-4, the pace of execution was average, the interval of rest between the sets was 20-90 sec (HR – 110-120 bpm), between the series of exercises – till full recovery (HR – 90-100 bpm), the character of the rest intervals was active, was used. The exercises in complicated conditions (the use of additional weight in exercises with weight of one's own body, the performance of the set in a state of incomplete recovery (HR – 120-130 bpm), etc.) were used as a training technique for the development of power endurance of cadets. The activity dosing was carried out by increasing the duration of the exercise, reducing rest intervals, adjusting the weights (but not less than 20% and not more than 70% of the maximum).

A significant component of the physical fitness of cadets, engaged in kettlebell lifting, is the level of development of flexibility which is determined by the ability to perform movements with the greatest possible amplitude. The well-developed flexibility contributes to the efficient mastering of rational physical exercise techniques, strengthening the joints, improving the strength and elasticity

of muscles, ligaments, and tendons, improving coordination skills that greatly prevents the injuries of the musculoskeletal system.

A personal coaching experience showed that a high level of power and endurance development, and functional capabilities of a kettlebell-lifter are irrelevant because the low level of flexibility and mobility of the joints will not allow him to master the rational technique of performing exercises with kettlebells and to achieve high results in kettlebell lifting. The level of flexibility depends on the following factors: the individual features of the joint structure (the shape, the length of the joint surfaces), the features of the musculoskeletal system (the muscle strengths that perform movements in this joint, the elasticity of the ligaments and tendons), the muscles that can increase their length by 30-40% of the length at rest during physical training for the development of flexibility. Therefore, the ability to combine the voluntary (conscious) antagonist muscle relaxation with synergistic muscle tension plays a decisive role in the development of the kettlebell-lifters` flexibility.

The joint mobility may be limited by insufficient flexibility of antagonist muscles, ligaments, and tendons to perform high amplitude motions. In this case, the flexibility will depend on both the strength of the synergist muscles and the elasticity of the antagonist muscles. In the course of the introduction of the authors' methodology, we took into account that the ability of muscles to stretch is improved with the increase in their temperature and blood flow (under the influence of warm-up). The active and passive flexibility are distinguished: the active flexibility is reflected in the movements that are carried out by the muscles performing a movement in this joint; the passive flexibility is reflected with the help of external forces by a partner, equipment, weights, and the action of other parts of one's own body. In the kettlebell lifting exercises, the active flexibility is reflected, for example, in the shoulder and elbow joints of the arms raised up in the phases of

squatting and fixing, the passive flexibility – in the spine, shoulder and elbow joints under the influence of the weights in the phase of the initial position in jerk.

The means of flexibility development, according to the authors' methodology include power exercises (exercises with weights), muscle relaxation exercises, muscle stretching exercises (active, passive, combined). The exercises with kettlebells used for the development of passive flexibility (holding the weights on the chest in the initial position and in the position of fixation), on the principle of double effect, contributed to improving the technical preparedness of cadets and the development of static endurance efficiently. During the development of the cadets' flexibility, we focused on the model characteristics and requirements of the appropriate tests, not developing the flexibility to the limit values, since the excessive stretch of joints can lead to their damage, and the muscles, ligaments, and tendons must perform a protective function of the joints. The flexibility exercises lasted from 20-30 sec to several minutes and the exercises with kettlebells (especially holding two kettlebells on the chest) lasted up to 10 minutes. It was taken into account that the stretching reflex (passive stretching in static exercises) disappeared after 15-20 sec of the exercise performance. The duration of rest between the exercises, depending on the level of the cadets' physical fitness and the nature of the exercises, ranged from 10-20 sec to several minutes. The exercises for the flexibility development of the cadets was carried out during a class in the following sequence: first, the exercises improving the mobility of the joints, surrounded by massive muscles (spine, hip, and shoulder muscles), and then those that are surrounded by small (elbow, ankle) were performed.

The group of methods aimed at the development of physical qualities, which were applied by the authors' methodology, include uniform, variable; interval, repeat, control and competitive.

According to the results of our own research, we developed model characteristics of general physical preparedness of cadets of different qualifications, engaged in kettlebell lifting (Table 1).

Table 1. Model characteristics of general physical preparedness of kettlebell lifters of different qualification (n=77, X±m)

Tests	The level of sports qualification		
	The 3rd and the 2nd grades (n=34)	The 1st grade and CMS (n=27)	MS, MSIL (n=16)
100 m race, sec	13.98±0.09	13.95±0.08	14.02±0.10
Pull-up bar exercise, reps	18.5±0.87	22.6±0.69	23.2±0.71
3 km race, sec	744.6±12.15	709.2±9.87	680.3±10.43
Push-up on parallel bars, reps	31.7±2.23	38.5±2.06	39.9±1.95
Complex power exercise, reps	69.7±2.70	78.8±2.45	80.4±2.18
Complex agility exercise, sec	9.2±0.18	8.5±0.21	8.2±0.25
Standing long jumps, sm	239.1±2.63	246.9±2.77	245.2±2.94
Forward inclinations of body, sm	15.2±0.63	17.1±0.69	18.9±0.57
Crossing arms behind the back, sm	2.4±0.49	5.8±0.52	8.7±0.61
Holding an angle on parallel bars, sec	98.1±2.75	116.4±2.90	123.9±3.27
Holding the body in a horizontal position, sec	207.2±4.96	221.5±5.04	238.0±5.54
Hang on the crossbar, sec	116.3±8.21	177.9±8.47	230.4±7.82
Squats with a barbell, kg	106.2±3.27	117.1±3.58	121.6±3.69
Bench press, kg	82.8±2.12	86.4±2.30	91.3±2.88
Deadlift, kg	104.9±2.94	118.6±3.07	133.5±3.27

The model characteristics let to reveal the reserves for the achievement of the planned results, to define the basic directions of the physical fitness improvement, to establish optimum levels of the development of its different sides for cadets, and to define the interconnections between them.

The application of models lets to compare individual data of a particular cadet with model characteristics, to assess the advantages and disadvantages of one's preparedness and, on this basis, to plan and adjust the training process, to select means and methods of influence.

To test the authors' methodology, we conducted a pedagogical experiment, lasting 5 years, during which we investigated the level and dynamics of physical qualities' development of cadets, engaged in kettlebell lifting, concerning the authors' methodology (EG) and cadets, engaged in kettlebell lifting, not taking into account the issues of the authors' methodology (CG).

The analysis of the 100 m race results showed that the level of development of speed qualities of cadets had not differed significantly ($p>0.05$) in the 1st – 3rd years of study, the indicators of the CG cadets had been significantly better than the EG cadets' by 0.29 sec in the 4th year of study, and by 0.35 sec in the 5th year of study ($p<0.01$) (Table 2). The dynamics analysis of the 100 m run results during the pedagogical experiment showed that the level of speed qualities had been improved in both groups: by 0.48 sec in the EG ($p<0.01$), and by 0.86 sec in the CG ($p<0.001$). However, the level of speed qualities during all years of study was rated as good in the EG, and as excellent in the CG in the 3rd – 5th years of study. It indicates that speed qualities are not informatively important for achieving high results in kettlebell lifting.

The study of the results in the 3 km race showed that the results of the EG and CG cadets had been equal authentically in the 1st year of study ($p>0.05$), and the EG cadets had been revealed to have a significantly better level of endurance development than the CG cadets by 21.1 sec in the 2nd year of study ($p<0.05$). In the 3rd and 4th years of study, the difference between the results of the EG and CG was increased to 30.8 sec and 33.2 sec respectively ($p<0.01$). In the 5th year of study, the best result in the 3 km race was recorded in the EG (11 min 14 sec) that was 40.3 sec less than in the CG (11 min 54 sec) ($p<0.001$) (Table 2).

Table 2. The dynamics of the development of speed, general endurance, flexibility and static endurance of the EG and CG cadets during the pedagogical experiment

(X±m, n=86)

Years of study	EG (n=29)	CG (n=57)	Significance value, p
100 m race, sec			
1st	14.56±0.13	14.59±0.09	>0.05
2nd	14.39±0.12	14.25±0.09	>0.05
3rd	14.21±0.11	14.02±0.08	>0.05
4th	14.13±0.10	13.84±0.07	<0.05
5th	14.08±0.09	13.73±0.07	<0.01
p(1–5)	<0.01	<0.001	
3 km race, sec			
1st	792.4±8.96	797.8±6.78	>0.05
2nd	733.8±8.15	754.9±6.43	<0.05
3rd	703.3±7.56	734.1±6.31	<0.01
4th	686.6±6.37	719.8±6.18	<0.01
5th	673.9±6.03	714.2±5.94	<0.001
p(1–5)	<0.001	<0.001	
Forward inclination of body from a sitting position, sm			
1st	6.1±0.65	5.9±0.41	>0.05
2nd	11.9±0.63	7.1±0.45	<0.001
3rd	16.5±0.61	9.0±0.49	<0.001
4th	18.1±0.58	10.6±0.56	<0.001
5th	19.6±0.56	11.2±0.59	<0.001
p(1–5)	<0.001	<0.001	
Holding the body in a horizontal position, sec			
1st	97.4±3.75	103.1±2.66	>0.05
2nd	118.9±3.92	112.4±2.91	>0.05
3rd	167.2±4.17	127.9±3.25	<0.001
4th	212.6±4.46	139.1±3.58	<0.001
5th	234.1±4.68	151.3±3.89	<0.001
p(1–5)	<0.001	<0.001	

The positive influence of the lessons by the authors' methodology on the level of endurance development is also confirmed by the increase in the 3 km race results during the pedagogical experiment – the EG cadets were found to have the biggest difference in the initial and final data of the study, it accounted for 1 min 58 sec ($p<0.001$). The endurance indicators were improved by 1

min 24 sec in the CG ($p<0.001$) that indicates a more prominent positive effect of the classes carried out according to the authors' methodology, in contrast to the current one.

The study of the level of flexibility development of cadets indicated a low level of this characteristic development for the majority of the cadets of both groups at the beginning of the study – the average results in the forward inclination of the body of the cadets in the 1st year of study were not significantly different ($p>0.05$) and were estimated as unsatisfactory.

The positive effect of the classes by the authors' methodology was observed in the 2nd year of study: the indicators of the EG were significantly better than the CG's by 4.8 sm ($p<0.001$) (Table 2). In senior years of study, the difference between the results of the EG and CG cadets was increased to 8.4 sm at the end of the experiment ($p<0.001$). During the formative stage of the pedagogical experiment, the level of flexibility was improved significantly in both groups ($p<0.001$) – the difference in the indicators at the beginning and at the end of the study was 5.3 sm in the CG, and 13.5 sm in the EG. It should be mentioned that the level of flexibility was rated as excellent in the EG in the 3rd – 5th years of study, and as satisfactory in the CG in the senior years of study.

The analysis of the results in holding the body in a horizontal position showed that the indicators of the groups had not differed significantly in the 1st – 2nd years of study ($p>0.05$) In the 3rd – 5th years of study a significant advantage of the results of the EG cadets over the results of the CG cadets was revealed ($p<0.05$-0.001). The greatest effect of the classes carried out according to the authors' methodology on the development of static endurance of the back muscles was found at the end of the experiment, when the EG cadets' average result in this exercise was the best (3 min 54 sec) and significantly better than in the CG (2 min 31 sec) by 1 min 23 sec ($p<0.001$) (Table 2). During the study period, the cadets' results were improved authentically ($p<0.001$). However, the

difference in the initial and final data was 48.2 sec in the CG, and the difference was much larger in the EG (2 min 17 sec) that confirmed the advantage of the authors' methodology.

The study of the results in pull-up bar exercises indicated that there was no significant difference in the indicators of the groups in the 1st year of study ($p>0.05$). In the 2nd – 5th years of study, the results of the EG cadets appeared to be significantly better than of the CG ($p<0.001$) (Table 3), that proved the efficiency of the authors' methodology for developing the power qualities of the cadets who are future officers. The dynamics analysis of the results of pull-ups during the experiment showed that the results were improved authentically in both groups ($p<0.001$). However, the difference in the cadets' results at the end and the beginning of the study was 5.8 reps in the CG, and 8.8 reps in the EG that indicated the advantage of classes held by the authors' methodology.

The analysis of the cadets' results in hip-swing-up with a pull-up bar showed that the indicators of the EG cadets had the advantage of the CG cadets from the 2nd year of study ($p<0.01$-0.001) (Table 3). In the 5th year of study, the difference in the results of the EG and CG cadets was the biggest during the experiment and it accounted for 6.7 reps significantly ($p<0.001$). During the experiment, the results in the hip-swing-up were increased authentically in both groups ($p<0.001$). The difference in the initial and final data of the experiment accounted for 3.5 reps in the CG, and 10.3 reps in the EG.

The study of the dynamics of the cadets' results in push-up on parallel bars and complex power exercise showed a similar trend of the results to the results in pull-up bar exercise and hip-swing-up with a pull-up bar during the experiment – the lack of the authentic difference in the results of the cadets of the groups in the 1st year of study ($p>0.05$) and significant predominance of power qualities of the EG cadets in the 2nd – 5th years of study ($p<0.001$).

Table 3. The dynamics of the power qualities' development of the EG and CG cadets during the pedagogical experiment (X±m, n=86).

Years of study	EG (n=29)	CG (n=57)	Significance value, p
Pull-up bar exercise, reps			
1st	12.1±0.71	12.3±0.52	>0.05
2nd	16.9±0.68	14.6±0.51	<0.05
3rd	18.8±0.64	16.3±0.49	<0.01
4th	21.5±0.61	17.2±0.45	<0.001
5th	22.7±0.59	18.1±0.47	<0.001
p(1–5)	<0.001	<0.001	
Hip-swing-up, reps			
1st	4.8±0.70	4.9±0.49	>0.05
2nd	9.1±0.69	6.2±0.47	<0.01
3rd	11.7±0.68	7.1±0.54	<0.001
4th	13.2±0.68	7.6±0.52	<0.001
5th	15.1±0.66	8.4±0.55	<0.001
p(1–5)	<0.001	<0.001	
Push-up on parallel bars, reps			
1st	14.5±1.06	15.1±0.81	>0.05
2nd	23.2±1.12	16.9±0.85	<0.01
3rd	29.4±1.33	19.3±0.90	<0.001
4th	34.6±1.23	22.1±0.96	<0.001
5th	38.1±1.31	25.2±1.02	<0.001
p(1–5)	<0.001	<0.001	
Complex power exercise, reps			
1st	47.8±1.34	47.2±1.04	>0.05
2nd	60.2±1.43	55.3±1.32	<0.51
3rd	68.9±1.52	60.1±1.49	<0.001
4th	77.5±1.61	61.9±1.53	<0.001
5th	81.4±1.69	63.8±1.61	<0.001
p(1–5)	<0.001	<0.001	

The highest results in these exercises were recorded in the EG in the 5th year of study (38.1 reps in push-up on parallel bars and 81.4 reps in complex power exercise). During the study period, the power level of the cadets was improved in push-up on parallel bars by 10.1 reps in the CG and 23.6 reps in the EG ($p<0.001$); in complex power exercise – by 16.6 reps in the CG, and 33.6 reps in the EG ($p<0.001$) (Table 3).

Thus, the study of the physical fitness of the EG and CG cadets showed a significant influence of the classes carried out according to the authors' methodology on the development level of the basic physical qualities of future officers. In addition, the introduction of the authors' methodology for the development of physical qualities in the educational and training process of S. P. Koroliov Zhytomyr Military Institute contributed to a significant increase in the results of cadets engaged in kettlebell lifting.

Among the cadets in the last 5 years, 14 cadets became the Masters of Sports of Ukraine, 31 cadets became the Candidate Masters of Sports, 22 cadets become champions and winners of championships of Ukraine among adults and juniors; the representative team of S. P. Koroliov Zhytomyr Military Institute was ranked only the first in all championships of HMEI of Ukrainian Armed Forces. All this proves the efficiency of the authors' methodology of the physical qualities' development of cadets.

CONCLUSIONS.

The authors' methodology of the physical qualities' development of cadets during kettlebell lifting activities is substantiated and the model characteristics of the physical preparedness of cadets of different sport qualifications are developed.

The significantly better level of the EG cadets' development of physical qualities, in comparison to the CG cadets' ($p<0.05$-0.001) was established at the end of the pedagogical experiment, according to the results in the following tests: the 3 km race – by 40.3 sec, forward inclination of the body – by 8.4 sm, holding the body in a horizontal position – by 1 min 23 sec, pull-up bar exercises – by 4.6 reps, hip-swing-up – by 6.7 reps, push-up on parallel bars – by 12.9 reps, complex power exercise – by 17.6 reps. It indicates the positive influence of the authors' methodology on the level of physical qualities' development of cadets during kettlebell lifting activities.

The high development level of physical qualities of cadets will ensure the efficient performance of the tasks in the conditions of their future military-professiona activity.

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RECIBIDO: 3 de diciembre del 2019. **APROBADO:**17 de diciembre del 2019.