ORIGINAL ARTICLE

CONTENTS

# The impact of strength loads on the health status and physical readiness of female cadets

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## ABSTRACT

**Aim:** To investigate the impact of kettlebell strength training on the health and physical readiness of female cadets during martial law training.

**Materials and Methods:** The research involved 60 female cadets, 30 each in the experimental (EG) and the control (CG) groups. The EG cadets were engaged in kettlebell exercises during the hours of their sporting and mass participation activities, while the CG cadets were engaged according to the traditional methodology. The health status was assessed by anthropometry and cardiovascular system indicators; physical readiness – by the results of 100 meter run, push-ups, and 1 km run.

**Results:** It was found that at the end of the research, most indicators of health and physical readiness in female cadets engaged in kettlebell exercises were significantly better than those who were engaged in physical exercises according to the traditional methodology. The most pronounced effect of strength loads was found on the development of strength qualities, stabilization of body weight, and improvement of the functional capabilities of the cardiovascular system. In the 4th semester, the female cadets of the EG showed significantly better than in the CG indicators of BMI, SI, heart rate recovery time, LPH, results in push-ups, and 1 km run.

**Conclusions:** It is proved that strength loads in exercises with kettlebells, having several positive features, effectively impact the state of health and development of motor skills in female cadets, as well as contribute to the formation of an aesthetic physique and weight loss.

**KEY WORDS:** health, physical readiness, strength loads, kettlebell exercises, female cadets, martial law

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## INTRODUCTION

According to statistical data, more than 43,000 servicewomen are currently serving in the Armed Forces of Ukraine, which is almost 3 times more than in 2014. Almost 8,000 women serve as officers, more than 11,000 as sergeants, almost 23,000 as soldiers, and more than 1,300 women are cadets in higher military educational institutions (HMEIs). More than 5,000 servicewomen perform tasks in the combat zone on an equal footing with men. The tendency to increase the number of women willing to serve is observed not only in the Armed Forces of Ukraine but also in other uniformed services and agencies of Ukraine, which is in line with the standards of NATO member states [1-3].

The current hostilities with the russian aggressor are accompanied by great physical and mental stress on military personnel, including women [4]. Constantly wearing a helmet, a body armor vest, a load-bearing system, with weapons and equipment, carrying arms materiel and ammunition, transporting the wounded, moving on the battlefield while overcoming obstacles, jumping on and off vehicles as well as armored vehicles, into trenches, fighting positions, jumping over them, etc. requires good health and a high level of motor skills in servicewomen, in particular the strength of the muscles of the back, legs, and shoulder girdle.

In this regard, there is a contradiction between the specifics, conditions, and requirements of modern military service and the educational process in HMEIs, on the one hand, and the anatomical and physiological characteristics of the female body and the level of development of their motor skills to ensure the quality of assigned tasks, on the other. This necessitates the search for effective means of physical training of female cadets

that would help to promote their health, increase the amount of motor activities, and improve the development of their motor skills. In addition, when selecting and justifying physical education means, it is necessary to take into account the current conditions of training female cadets during the legal regime of martial law (prolonged stay in shelters, bunkers during frequent air raids and missile danger) and the possibilities of the location of units (usually outside the permanent deployment point, in a limited space, without access to sports facilities) [5, 6]. Exercises with weights, in particular with kettlebells, can be one of the means of physical education of female cadets during the period of martial law, promoting their health and targeted development of back, leg, and shoulder girdle muscles [7, 8]. Exercises with kettlebells do not require much place and free space (exercises with kettlebells can be performed in bomb shelters, narrow and low rooms, in restricted space conditions, etc.) [9, 10]. However, no studies have been conducted on the impact of strength loads during kettlebell exercises under martial law on health and physical readiness of female cadets.

## AIM

The aim is to investigate the impact of kettlebell strength training on the health and physical readiness of female cadets during martial law training.

## MATERIALS AND METHODS

The research was conducted at the Military Institute of Taras Shevchenko National University of Kyiv in 2022-2024. The research involved 60 female cadets who entered the HMEI in 2022. In September 2022, we formed two groups of 30 female cadets each: the EG, which included female cadets who enrolled in the specialty 035 "Philology" and practiced during the hours of sporting and mass participation activities (SMPAs) according to the kettlebell complexes developed by the authors; the CG included female cadets who enrolled in the specialty 053 "Psychology" and practiced during the hours of SMPAs according to the traditional methodology. At the beginning of the research, there was no significant difference between the indicators of health status and physical fitness of female cadets.

Training sessions during the hours of SMPAs in both groups were held three times a week for 1 hour each; in the EG under the guidance of a kettlebell lifting coach, and in the CG – under the guidance of the cadet unit commander. For the EG, we developed a set of exercises with kettlebells weighing 8, 12, 16, 20, and 24 kg, which was aimed at strengthening the muscles of the back, legs, and shoulder girdle in female cadets. The exercises in the course of training sessions were combined into sets of 5-7 exercises for the development of different muscle groups in female cadets. The main exercises with kettlebells for the EG included squats with a kettlebell, jumping up with a kettlebell, kettlebell swings, lifting, snatches, pulling, kettlebell deadlifts (bent-over rowing, chin deadlifts), kettlebell press standing, sitting, lying, etc. In the CG, training sessions were conducted with the use of gymnastic exercises (pull-ups on a low bar, push-ups, sit-ups, etc.) and exercises with body weight (bends, squats, jumps, jumping-ups, etc.). The exercises were also combined into sets of 5-7 exercises like in the EG. All training sessions in the EG and the CG were conducted in a circular method of 3-5 circles, depending on the complexity of the exercises and the duration of rest between exercises and circles. The research of indicators of health status and physical fitness of female cadets in the EG and the CG was carried out during 4 stages: during their training in the 1$^{st}$, 2$^{nd}$, 3$^{rd,}$ and 4$^{th}$ semesters.

Research methods: theoretical (analysis, synthesis, generalization of literary sources), empirical (methods of health assessment, testing of physical qualities), methods of mathematical statistics. The health status of female cadets was assessed according to the methodology of Professor H. L. Apanasenko [11], which is based on anthropometric indicators (body weight and length, vital capacity of the lung, hand dynamometry), as well as the state of the cardiovascular system (heart rate, blood pressure, pulse recovery time). The methodology involved determining the sum of points for each of the 5 indicators (calculated indices): body mass index (BMI), vital index (VI), strength index (SI), Robinson index (RI), and heart rate recovery time (HRRT) after 20 squats in 30 seconds. According to the methodology of H. L. Apanasenko, low level of health corresponded to 3 or less points, below-average – 4-6 points, average – 7-11 points, above-average – 12-15 points, high level of health – 16-18 points. The physical readiness of female cadets was assessed by the following tests: 100 meter run, push-ups, and 1 km run. Testing was carried out in a sports uniform. One attempt was allowed for each exercise, and all exercises were tested within one day. The methods of mathematical statistics were applied to correctly process the data and identify the difference between EG and CG female cadets' indicators. The compliance of the data distribution with the Gauss' law was assessed using the Shapiro-Wilk W-test. The authenticity of the difference between the female cadets'indicators was determined by means of Student's test. The significance for all statistical tests was set at $p<0.05$. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all female cadets who took part in this research.

**Table 1.** Dynamics of health indicators in female cadets of the EG and the CG during their training in the 1st-4th semesters at the HMEI (M ± m, n = 60)

| Stages of research | EG (n=30) | CG (n=30) | Significance of difference, pEG-CG |
|---|---|---|---|
| BMI, kg/m$^2$ | | | |
| 1st | 21.3±0.34 | 21.4±0.31 | >0.05 |
| 2nd | 21.0±0.32 | 21.8±0.29 | >0.05 |
| 3rd | 20.7±0.30 | 21.9±0.29 | <0.05 |
| 4th | 20.6±0.29 | 22.0±0.30 | <0.01 |
| p1-4 | >0.05 | >0.05 | |
| VI, ml/kg | | | |
| 1st | 49.8±1.42 | 50.2±1.40 | >0.05 |
| 2nd | 52.3±1.39 | 51.5±1.41 | >0.05 |
| 3rd | 53.7±1.38 | 52.1±1.39 | >0.05 |
| 4th | 54.9±1.37 | 53.4±1.40 | >0.05 |
| p1-4 | <0.05 | >0.05 | |
| SI, % | | | |
| 1st | 40.2±1.24 | 40.4±1.22 | >0.05 |
| 2nd | 44.8±1.22 | 40.5±1.18 | <0.05 |
| 3rd | 49.3±1.21 | 40.6±1.19 | <0.001 |
| 4th | 53.9±1.19 | 40.5±1.17 | <0.001 |
| p1-4 | <0.001 | >0.05 | |
| RI, c. u. | | | |
| 1st | 80.9±1.44 | 80.7±1.38 | >0.05 |
| 2nd | 80.2±1.41 | 80.5±1.37 | >0.05 |
| 3rd | 79.6±1.39 | 80.4±1.37 | >0.05 |
| 4th | 78.8±1.38 | 80.2±1.36 | >0.05 |
| p1-4 | >0.05 | >0.05 | |
| HRRT, s | | | |
| 1st | 135.1±3.60 | 134.9±3.54 | >0.05 |
| 2nd | 124.4±3.43 | 129.6±3.48 | >0.05 |
| 3rd | 116.2±3.37 | 122.6±3.45 | >0.05 |
| 4th | 107.6±3.29 | 117.5±3.42 | <0.05 |
| p1-4 | <0.001 | <0.01 | |
| LPH, points | | | |
| 1st | 4.03±0.82 | 4.13±0.71 | >0.05 |
| 2nd | 6.92±0.79 | 4.82±0.70 | >0.05 |
| 3rd | 7.37±0.80 | 5.27±0.69 | <0.05 |
| 4th | 9.41±0.77 | 5.90±0.68 | <0.01 |
| p1-4 | <0.001 | >0.05 | |

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of female cadets; t – t-test value; p – significance of difference between the indicators of female cadets.

## RESULTS

The results of the research of health indicators of the EG and the CG female cadets are given in Table 1. The analysis of BMI showed that during the 1st and 2nd semesters, the indicators of the EG and the CG did not differ significantly ($p > 0.05$). In the 3rd and 4th semesters BMI in the EG female cadets, due to stabilization of body weight, was significantly better than in the CG, by 1.2 and 1.4 kg/m$^2$, respectively ($p < 0.05$; $p < 0.01$). During the study period, BMI in the EG improved by 0.7 kg/m$^2$, and in the CG – deteriorated by 0.7 kg/m$^2$, but no significant difference was revealed between the indicators of the 1st and 4th semesters ($p > 0.05$) in both groups. At the same time, BMI was within the age norm

**Table 2.** Dynamics of physical readiness indicators in female cadets of the EG and the CG during their training in the 1st-4th semesters at the HMEI (M ± m, n = 60)

| Stages of research | EG (n=30) | CG (n=30) | Significance of difference, pEG-CG |
|---|---|---|---|
| 100 meter run, s | | | |
| 1st | 16.9±0.18 | 16.8±0.20 | >0.05 |
| 2nd | 16.7±0.17 | 16.7±0.19 | >0.05 |
| 3rd | 16.6±0.17 | 16.6±0.19 | >0.05 |
| 4th | 16.5±0.16 | 16.6±0.18 | >0.05 |
| p1-4 | >0.05 | >0.05 | |
| Push-ups, times | | | |
| 1st | 22.4±0.85 | 22.3±0.72 | >0.05 |
| 2nd | 23.9±0.79 | 22.8±0.70 | >0.05 |
| 3rd | 25.7±0.73 | 24.8±0.68 | >0.05 |
| 4th | 29.3±0.66 | 27.1±0.65 | <0.05 |
| p1-4 | <0.001 | <0.001 | |
| 1 km run, s | | | |
| 1st | 292.3±2.38 | 296.9±2.55 | >0.05 |
| 2nd | 281.5±2.19 | 285.1±2.39 | >0.05 |
| 3rd | 277.2±2.07 | 282.5±2.34 | >0.05 |
| 4th | 269.7±1.98 | 277.5±2.18 | <0.05 |
| p1-4 | <0.001 | <0.001 | |

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of female cadets; t – t-test value; p – significance of difference between the indicators of female cadets.

and corresponded to the average level in both groups. No significant difference was found in VI between the EG and the CG at all stages of the research ($p > 0.05$), but in the EG the functional capacity of the respiratory system improved significantly ($p < 0.05$) during the training period in the 1st – 4th semesters by 5.1 ml/kg, and in the CG the changes, which amounted to 3.2 ml/kg, were not significant ($p > 0.05$). At the beginning of the research in both groups, VI corresponded to a below-average level, and at the end – to the average level.

A positive, pronounced effect of strength loads on the body of female cadets was established by the indicators of SI. Thus, a significant difference between the indicators of SI in female cadets of the EG and the CG was found already in the 2nd semester – 4.3 % ($p < 0.05$), and in the 3rd and 4th semesters the indicators of SI in the EG were significantly better than in the CG by 8.7 % and 13.4 % ($p < 0.001$). During the training, the strength capabilities of female cadets of both groups improved, but a significant difference between the indicators of the 1st and 4th semesters was found only in the EG (13.7 %; $p < 0.001$), which indicated the effectiveness of strength exercises with kettlebells on the development of muscle strength in female cadets. The analysis of RI showed that both groups were characterized by an improvement in the functional capabilities of female cadets' cardiovascular system, corresponding to the above-average level, but a significant difference at any stage of the research was not found ($p > 0.05$). The dynamics of the HRRT in women of both groups was positive for the period of the research, and the difference between the initial and final data in both EG and CG was reliable ($p < 0.001$; $p < 0.01$), but better HRRT by 9.9 s was recorded ($p < 0.05$) in the EG women during their 4th semester of training

The analysis of the level of physical health (LPH) according to the method of H. L. Apanasenko showed that in both groups there was an improvement in the health of female cadets during their training at the HMEI. However, during the research period, the LPH in the EG improved by 5.38 points ($p < 0.001$), and in the CG – by 1.77 points ($p > 0.05$). At the end of the research, the LPH in the EG was 3.51 points higher than in the CG ($p < 0.01$). At the same time, starting from the 2nd semester, the LPH in the EG was assessed as "average", and in the CG at all stages of the research – "below-average". This indicates the positive impact of kettlebell strength training on the health status of female cadets during their training in the 1st-4th semesters. In the case of continuation of exercises with kettlebells, it is possible to predict further improvement of the health status of female cadets to above-average and high levels in the

senior years of training.

The results of the assessment of physical readiness indicators in female cadets of the EG and the CG during their training in the 1st-4th semesters at the HMEI are presented in Table 2. It was found that for all tests at the beginning of the research, there was no significant difference between the indicators of the EG and the CG ($p > 0.05$). The study of results characterizing the development of high-speed qualities shown by female cadets in 100 m runs indicates that in both groups there was an improvement of results by 0.4 and 0.2 s respectively ($p > 0.05$), but between the EG and the CG, there was no significant difference at all stages of the research ($p > 0.05$). This indicates that both strength loads with kettlebells and traditional training sessions during the hours of SMPAs have a positive effect on the development of speed qualities of female cadets. In the 4th semester, the results of 100 meter run in the EG were evaluated as "good", and in the CG – as "satisfactory".

The dynamics of the development of strength qualities in female cadets of the EG and the CG was positive, but the growth of results in the EG prevailed over the CG, starting from the 2nd semester. The difference between the results of female cadets of the EG and the CG in the 2nd semester was 1.1 times ($p > 0.05$), in the 3rd – 0.7 times ($p > 0.05$), and in the 4th – 2.2 times ($p < 0.05$). At the same time, during the research period the results of the EG significantly increased by 6.9 times ($p < 0.001$) and were estimated in the 4th semester as "excellent", and in the CG – by 4.8 times ($p < 0.001$), the grade was "good". The research of endurance development level by results of 1 km run testified to a significantly ($p < 0.001$) positive dynamics of results in both groups. At the same time, in the 1st-3rd semesters there was no significant difference between indicators of the EG and the CG, and in the 4th semester indicators in the EG were significantly better than in the CG by 7.8 s ($p < 0.05$). This allows us to assert that strength loads during kettlebell training not only did not interfere with the development of endurance in female cadets but even contributed to its development. In the 4th semester, the results of running 1 km in both groups were rated as "excellent". In general, strength loads during kettlebell training had a positive impact on both the health and physical readiness indicators of female cadets.

## DISCUSSION

According to scientists [7, 12], today strength exercises with weights and, in particular, with kettlebells are quite popular among the female half of humanity. This is evidenced by a significant number of competitions in strength sports in our country and abroad among students, girls, and women; an annual growth in the number of female participants in these competitions and an increase in the level of their physical fitness and sportsmanship; inclusion of kettlebell exercises in various health and fitness programs for women, CrossFit training, weight loss programs, etc. However, strength loads during weight-bearing exercises require taking into account certain anatomical and physiological features of the female body compared to the male body to maximize the benefits of training. When comparing the functional capabilities of women and men, it is necessary to take into account the difference in body size, the capabilities of the muscular system, as well as the rhythmic functioning of the ovarian-menstrual cycle (OMC). Experts [13] note that the total muscle strength in women is about 70 % of this indicator in men; women have relatively weak muscles of the upper extremities and trunk, and their maximum strength is 40-70 % of the strength of these muscles in men. At the same time, the strength of the leg muscles in women is only 2.7 % less than in men [14]. Working muscle hypertrophy, which is regulated mainly by sex hormones, is less pronounced in women than in men. Therefore, strength training has a greater effect on reducing adipose tissue in women and a relatively smaller effect on increasing muscle volume. In men, muscles make up about 40-50 % of body weight, in women about 30 %; the amount of adipose tissue in men is about 20 %, in women – 30 % of body weight [15]. The vital capacity of the lungs in men is 4300-4600 ml, in women – 3200-3400 ml; the resting heart rate in men is 62-72 beats per minute, in women – 70-80 beats per minute; the heart in women is 10-20 % smaller than in men. Women have an increased excitability of the nervous system, a longer recovery period after strength training, and a rapid loss of fitness in the event of a training interruption.

In the works of scientists [9, 16], the advantages of kettlebell exercises in the absence of the possibility of using other sports equipment are noted: simplicity and accessibility of exercises for people of different sexes and ages, as well as with different levels of physical fitness, compactness of equipment, content-richness (the total number of kettlebell exercises can be more than 100), wellness orientation, minimal injury rate, cost-effectiveness, etc. All you need for kettlebell training is a set of kettlebells of different weights. Kettlebell training does not require any special conditions: it can be done outdoors and in confined spaces, and you can do it alone or in a group. Systematic kettlebell exercises contribute to the development of strength, endurance, and coordination of movements; improve body structure; help to improve self-confidence, self-esteem, perseverance, and determination [10, 17]. The availability of kettlebell

exercises for women with different physical development allows them to effectively solve the problems of body shaping and physique correction (weight loss, weight reduction, strengthening of abdominal and back muscles), strengthening of the musculoskeletal system, cardiovascular and respiratory systems [8, 18]. Muscle "corset" ensures the correct position and functioning of the spine and internal organs in women, improves blood supply to the brain, and, as a result, increases mental and physical performance. In the process of training with kettlebells, women also learn vital skills and abilities to handle weights correctly. All of the above confirms the expediency of using strength loads in kettlebell exercises for female cadets, forming in them all the necessary motor and psychological qualities necessary for their educational and future military professional as well as combat activities.

Researches are devoted to the problem of improving the level of physical fitness of servicewomen [19, 20]. The question of the use of means of kettlebell sport for the development of motor qualities of servicemen and male cadets, and also improvement of their sports results was the subject of scientific research by some scientists. However, the use of exercises with kettlebells in the physical training of female cadets to promote their health status, and increase the level of development of their strength qualities during training at HMEIs during the period of the right regime of martial law remained without the attention of specialists. The results of our research have expanded the conclusions of existing works [9, 10, 18] on the benefits of strength loads on the health status and physical readiness of military personnel.

## CONCLUSIONS

It was found that at the end of the research, most indicators of health and physical fitness in female cadets engaged in kettlebell exercises were significantly ($p < 0.05$-$0.001$) better than those who were engaged in physical exercises according to the traditional methodology. The most pronounced effect of strength loads was found on the development of strength qualities, stabilization of body weight in women, and improvement of the functional capabilities of the cardiovascular system. In the 4$^{th}$ semester, the female cadets of the EG showed significantly better than in the CG indicators of BMI, SI, heart rate recovery time, LPH, results in push-ups, and 1 km run. It is proved that strength loads in exercises with kettlebells, having several positive features, effectively impact the state of health and development of motor skills in female cadets, as well as contribute to the formation of an aesthetic physique and weight loss.

The level of health and physical readiness formed in the 1$^{st}$ and 2$^{nd}$ training years will help to increase the body's resistance to adverse factors of educational activities, improve the efficiency of performance of service duties, and the formation of military-applied skills in female cadets during their senior training years and in the course of their future military professional as well as combat activities.

## THE PROSPECT OF FURTHER RESEARCH

It is planned to investigate the effect of strength loads in kettlebell exercises on the restoration of the psycho-emotional state of female cadets in a war.

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**CONFLICT OF INTEREST**

The Authors declare no conflict of interest

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