# Circuit training method to improve strength endurance of cadets

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**Abstract**

**Objective of the study** was to assessment of the effectiveness of using the circuit training method in increasing the strength endurance of students at a military training center.

**Methods and structure of the study.** To achieve this goal, a pedagogical experiment was conducted on the basis of the Educational Training Center at National Research Tomsk State University, in which 16 5th year students (male, age 22-23 years) enrolled in the military training program for personnel officers took part. From their number, experimental and control groups of eight people each were formed. The experimental group worked out according to a training plan, which contained exercises performed using the circuit training method.

**Research results and conclusions.** The circuit training method can provide the greatest increase in results when used in exercises with a more pronounced strength component or external resistance factor - for example, in exercises with weights (squats with a barbell), since short series with a change in the muscle regions exposed to the impact provide better recovery between approaches bioenergetic systems responsible for the manifestation of strength abilities.

**Keywords:** *military training center, military applied physical training, strength endurance, circuit training method, cadets*

**Introduction.** The absence of a physical education system for students undergoing military training at the Military Training Center gives rise to a number of problems, the main one being the inability to ensure the proper level of development of professionally significant physical qualities, primarily strength and endurance. At the same time, given the specifics of combat and everyday activities of military personnel, these qualities are manifested in a complex manner, in the form of strength endurance, the development of which, given many years of pedagogical practice, is more effectively carried out on the basis of the use of the circuit training method [2].

**Objective of the study** was to assessment of the effectiveness of using the circuit training method in increasing the strength endurance of students at a military training center.

**Methods and structure of the study.** To achieve the set goal, a 10-week pedagogical experiment was conducted at the Military Training Center of the Tomsk State University. 16 5th-year students (male, aged 22-23) studying under the program of military training of personnel officers took part in the experiment. An experimental and a control group of 8 people each were formed from them. The experimental group (EG) trained according to the training plan, which contained exercises performed using the circuit training method. In the control group (CG), exercises were performed using the repeated method during training sessions on gymnastics and athletic training. The results of the experiment were assessed through pedagogical testing using control exercises set out in the Manual on Physical Training in the Armed Forces of the Russian Federation (Order of the Ministry of Defense of the Russian

*Table 1. Example of a weekly training plan*

| Contents of the lesson | Methodological instructions |
|---|---|
| 1. Box jumps | – Exercises are performed using a repeated method;<br>– Intensity – non-maximum heavy weights (4-6 PM);<br>– Volume – up to 20 lifts in total in each exercise (no more than 5-6 repetitions in a set).<br>– Rest between sets – up to 3 min. |
| 2. Pull-ups with additional weights | |
| 3. Back squats | |
| 4. Barbell bench press | |
| 5. Barbell deadlift | |
| Uniform jogging at an easy pace for 10 minutes | |
| *According to the circuit training plan* | |
| 1. Uniform jogging at an easy pace | – Duration – 10-15 min.<br>– Heart rate – up to 130 bpm. |
| 2. Special running and jumping exercises | – 1 series of 30-50 m for each exercise (10-15 series in total) |
| 3. Cross or alternating running (with acceleration elements) | – Volume – up to 10 km;<br>– Intensity: Heart rate – up to 150 bpm. (or more – on very rough terrain)<br>– On slightly rough or flat terrain – free accelerations (fartlek) |

Federation dated 20.04.2023 No. 230): pull-ups on a horizontal bar, bending, unbending arms, in a prone position (push-ups), and squats with a barbell (70 kg) [1].

**Results of the study and discussion.** The assessment of the physical fitness of military personnel is carried out using physical exercises of the control and verification complex (CVC). Depending on age groups and service purpose, the list of assessed physical qualities may vary, while the physical qualities of strength and endurance are mandatory for all categories of military personnel.

It is known that strength as a physical quality can manifest itself in the form of strength, speed-strength abilities and strength endurance. Combat and everyday activities of troops often involve prolonged physical activity of medium or moderately high intensity (for example, carrying heavy objects over long distances, loading or unloading property, engineering equipment of the area). That is why, according to the instructions on physical training in the Armed Forces, when assessing the development of strength qualities, mainly strength endurance tests are used, the results of which are determined by the number of repetitions in exercises performed with the weight of one's own body or with a fixed weight. For example, performing the control exercise «pull-ups on the bar» in the amount of 25 repetitions on average takes about one and a half minutes - such a duration of work is possible only under the condition of a high level of development, to a greater extent of strength endurance, than of strength abilities themselves [1].

Thus, the need to develop strength endurance of military personnel is professionally significant. And for its effective development, the method of circuit training is more effective, using specially selected exercises, the use of which will contribute not only to the development of the basic physical qualities of military personnel, but also to the improvement of their complex manifestations [3].

With regard to military-applied physical training of students of the Military Training Center, the method of circuit training has the following advantages:

1. High motor density allows for short, but sufficiently intensive classes, for example, as part of independent training of students, the time for which is allocated in accordance with the daily routine of the Military Training Center.

2. The possibility of effective application of relatively simple technical exercises due to the lack of possibility to use complex equipment (for example, in the field or at stadiums, gymnastics grounds, etc.).

3. Organization of group classes using the circuit method, which involves simultaneous performance of different exercises at "stations", is more appropriate for military groups, due to their large number.

Since strength endurance is a complex quality, classes in the process of experimental work were programmed to develop its key components: strength, strength endurance, stamina. Thus, the experimental group studied according to the developed plan, which assumed three training sessions per week with the following content:

1. Exercises aimed at developing strength and speed-strength abilities (repeated method);

2. Exercises aimed at developing strength endurance (circuit training method);

[1] Order of the Minister of Defense of the Russian Federation dated April 20, 2023 No. 230 «On approval of the Manual on physical training in the Armed Forces of the Russian Federation»

*Table 2. Plan for constructing according to the principle of periodization with a linearly increasing intensity (expressed in the number of repetitions per approach) and a fixed total volume (60 pull-ups, 120 push-ups, 180 squats)*

| Week | Number of repetitions per set | | | Number of episodes | Total volume |
|---|---|---|---|---|---|
| | Pull-ups | Push-ups | Squats | | |
| 1 | 2 | 4 | 6 | 30 | 60 pull-ups<br>120 push-ups<br>180 squats |
| 2 | 3 | 6 | 9 | 20 | |
| 3 | 4 | 8 | 12 | 15 | |
| 4 | 5 | 10 | 15 | 12 | |
| 5 | 6 | 12 | 18 | 10 | |
| 6 | 7 | 14 | 21 | 9 | |
| 7 | 8 | 16 | 24 | 8 | |
| 8 | 9 | 18 | 27 | 7 | |
| 9 | 10 | 20 | 30 | 6 | |
| 10 | Sequential execution of each exercise (free number of repetitions and approaches) | | | | |

3. Cyclic aerobic exercises aimed at developing general endurance (uniform continuous and variable methods) (Table 1).

For the purposes of the pedagogical experiment, a series of exercises was used, which is a simplified version of the popular CrossFit complex «Murph», where there is no running component and additional weights, and strength exercises are performed in a circle [3].

In the control group, training sessions were also held three times a week, but in the second training session, the exercises were performed sequentially using the repeated method. The total volume was equal to the volume in the EG (in the free range of approaches and repetitions).

Testing the effectiveness of the developed technique was carried out at the ascertaining and control stages of the experiment. For this purpose, three control exercises were selected from the Manual on Physical Training in the Armed Forces of the Russian Federation, performed in the following sequence: No. 3 – «Pull-ups on the horizontal bar», No. 1 – «Bending and unbending arms in a lying position» and No. 16 – «Squats with a barbell on the shoulders».

Table 3 presents the testing results in the control and experimental groups, the comparison of which was carried out using the t-Student's criterion for independent samples. Differences were considered statistically significant at $p < 0,05$.

According to the testing results during the ascertaining experiment, no statistically significant differences were found in the level of development of strength endurance of the subjects of the experimental and control groups. The control experiment showed an increase in strength endurance indicators in both groups, while statistically significant differences were found only in two exercises: pull-ups on a horizontal bar and squats with a barbell.

*Table 3. Test results in the control and experimental groups*

| Group | Pull-ups on the horizontal bar | | | Bending and unbending arms in a lying position | | | Squats with a barbell 70 kg | | |
|---|---|---|---|---|---|---|---|---|---|
| | $x \pm m_x$ | t | p | $x \pm m_x$ | t | p | $x \pm m_x$ | t | p |
| *1. Ascertaining experiment* | | | | | | | | | |
| EG | 10,88 ± 1,30 | 0,23 | 0,83 (> 0,05) | 36,00 ± 5,86 | 0,25 | 0,81 (> 0,05) | 12,50 ± 1,77 | 0.41 | 0,69 (> 0,05) |
| KG | 10,50 ± 1,01 | | | 33,88 ± 6,19 | | | 11,38 ± 2,04 | | |
| *2. Control experiment* | | | | | | | | | |
| EG | 15,75 ± 1,43 | **2,20** | **0,046 (< 0,05)** | 42,50 ± 3,06 | 0.68 | 0,51 (> 0,05) | 18,13 ± 1,52 | **2.24** | **0,042 (<0,05)** |
| KG | 12,13 ± 1,08 | | | 38,25 ± 5,48 | | | 13,88 ± 1,19 | | |

**Conclusions**. The circuit training method can be effectively used to improve the strength endurance indicators of students studying in military training centers.

The circuit training method can provide the greatest increase in results when used in exercises with a more pronounced strength component or external resistance factor - for example, in exercises with weights (barbell squats), since short series with a change in muscle regions exposed to influence provide better recovery between approaches of bioenergetic systems responsible for the manifestation of strength abilities.

The circuit training method seems less effective when used in exercises with a longer duration of muscle tension (for example, in multi-repetition flexion and extension of the arms in a lying position), since the endurance component predominates in them.

**References**

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