

## METHODOLOGICAL FOUNDATIONS OF THE APPLICATION OF CIRCUIT TRAINING IN THE DEVELOPMENT OF PHYSICAL QUALITIES OF STUDENTS OF HIGHER EDUCATION INSTITUTIONS

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### INTRODUCTION

To effectively increase the intensity of physical education classes in educational institutions, including higher education institutions, as well as to specifically develop students' physical abilities and develop sustainable motor skills, a clearly structured and methodologically sound teaching system is necessary. Unlike elite sports, where the load is highly individualized, in the context of mass physical education, it is important to find a universal and manageable method. This system should be based on well-thought-out didactic principles, clearly defined methods, and organizational approaches, which together form a well-organized, streamlined, and pedagogically sound teaching methodology.

In this context, the principles of intensification translate into demands for increasing the motor density of the lesson (the ratio of time spent directly on exercises to the total lesson duration) and optimizing learning time. Time spent on organizational matters, explanations, and waiting for turns must be minimized. Achieving these goals is only possible through the use of organizational forms that allow for the simultaneous engagement of all students while maintaining the teacher's ability to monitor and correct them<sup>1</sup>.

An analysis of specialized literary sources and many years of practice confirm that the most rational, multifunctional and manageable tool for increasing the effectiveness of both a single educational or training session and the entire educational and training process is the use of the circuit training method<sup>2</sup>. Circuit training, developed in the 1950s by British specialists R. Morgan and G. Adams, is a unique organizational and methodological form

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<sup>1</sup> Данильченко С.І., Корнієнко Д.С., Мілкіна О.В., Мотуз С.О. Застосування методу колового тренування на заняттях з фізичного виховання студентів ВНЗ технічного профілю. *Вісник Запорізького національного університету. Фізичне виховання та спорт*. 2017, № 1. С. 34–41.

<sup>2</sup> Сиротинська О. К., Чеховська А. Ю. Колове тренування як дієвий засіб для гармонійного фізичного розвитку здобувачів вищої освіти. *Rehabilitation and Recreation*. 2023. №14. С. 236–241. <https://doi.org/10.32782/2522-1795.2023.14.28>

of physical exercise<sup>3</sup>. Its name derives from the cyclical (circular) performance of a set of exercises at successively arranged stations<sup>4</sup>.

The circuit training method has many undeniable advantages and deserves the widest possible dissemination in the practice of trainers, teachers and physical education instructors<sup>5</sup>.

The key value and advantages of circuit training lie, firstly, in the comprehensive development of physical qualities. Through the careful selection of exercises at stations, which can include alternating work on strength, endurance, flexibility, and coordination, this method allows for the effective development of several physical qualities simultaneously within a single session<sup>6</sup>. Secondly, circuit training ensures high motor and overall intensity of the session, as its use significantly increases work density: all trainees work simultaneously at different stations, eliminating downtime and lengthy waits typical of frontal or group training, thus ensuring maximum engagement for everyone<sup>7</sup>. Thirdly, circuit training allows for individualized load (dosing): students or athletes work independently at stations, completing a set number of repetitions (e.g., to failure or a fixed number) or work for a set time. This allows each individual to consider their individual characteristics, current level of physical fitness, and well-being, adjusting the pace and effort within the established methodological framework. Fourth, circuit training demonstrates universal applicability, being an effective method not only in sports training (for general fitness in sports, strength training, and martial arts), but also, most importantly, in physical education classes at higher education institutions, which require simultaneous participation by a large number of students and a variety of curriculum materials. Finally, circuit training helps increase motivation, as the cyclical change of activity, variety of exercises, and competitive element (self-

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<sup>3</sup> Шемчак І. А. Використання колового тренування в процесі підготовки спортсменів. *Матеріали XLVII науково-технічної конференції підрозділів Вінницького національного технічного університету*: збірник доп. (м. Вінниця, 13-14 березня 2018 р.). Вінниця: ВНТУ, 2018. С. 793–795.

<sup>4</sup> Scholikh Manfred. *Circuit Training: Perfect Fitness Program for All Sports*. Sport Books Publisher, 2001. 254 p.

<sup>5</sup> Гогоць В. Д., Остапова О. О., Остапов А. В. *Розвиток витривалості і сили: метод. посіб.* Полтава, 2010. 36 с.

<sup>6</sup> Антіпова Ж. І. Барсукова Т. О., Гоголева О. М. *Розвиток гнучкості у студентів закладів вищої освіти: метод. реком.* Одеса: видавець Букаєв Вадим Вікторович, 2021. 54 с.

<sup>7</sup> Терещенко В. І., Полухін Ю. В., Коропатов Б. М., Козлова К. П. Організація навчальних занять з фізичного виховання за методом колового тренування. *Науковий часопис Українського державного університету імені Михайла Драгоманова. Серія 15*. 2021. Вип. 11(143). С. 142–144. [https://doi.org/10.31392/NPU-nc.series15.2021.11\(143\).3](https://doi.org/10.31392/NPU-nc.series15.2021.11(143).3)

control or self-competition) contribute to increased interest and significantly reduce the monotony of the training process<sup>8</sup>.

Circuit training provides the maximum effect of intensification and comprehensive development of physical qualities only under the condition of strict adherence to the methodological principles of its application: an adequate selection of technically simple exercises, precise dosing of the load (number of repetitions, work time, weight of the weights) and a strictly regulated rest interval between stations and circuits<sup>9</sup>.

### **1. Basic options for using circuit training in physical education**

Traditional circuit training is based on three methods<sup>10</sup>.

*Continuous flow* training involves performing exercises one after another with short rest intervals. This method is characterized by a gradual increase in individual load by increasing the intensity of the work and the number of exercises in one or more circuits. Simultaneously, the time spent performing the exercises is reduced and the rest period is increased. This method promotes the comprehensive development of motor skills<sup>11</sup>.

*Flow-interval* training, which involves performing simple exercises at each station for 20-40 seconds with minimal rest. The goal is to reduce the time it takes to complete one or two circuits. This regimen develops overall and strength endurance and improves the respiratory and cardiovascular systems<sup>12</sup>.

*High-intensity interval* training, which is used as trainees' physical fitness improves. The intensity of its exercises is 75% of maximum, achieved by increasing intensity and reducing work time while maintaining standard volume and rest periods. This regimen develops maximum and

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<sup>8</sup> Ціпов'яз А. Т., Христова Т. Є., Антонова О. І. Практичні методи фізичного виховання та реабілітації: навч. посіб. Кременчук: Кременчуцький національний університет імені Михайла Остроградського, 2013. 140 с.

<sup>9</sup> Борисенко Н. В. Методичні рекомендації до організації самостійної роботи та проведення практичних занять із навчальної дисципліни «Фізичне виховання». Методика проведення колового тренування (для всіх освітніх програм Університету). Харків: ХНУМГ ім. О. М. Бекетова, 2019. 46 с.

<sup>10</sup> Данильченко С. І., Корнієнко Д. С., Мілкіна О. В., Мотуз С. О. Застосування методу колового тренування на заняттях з фізичного виховання студентів ВНЗ технічного профілю. *Вісник Запорізького національного університету. Фізичне виховання та спорт*. 2017, № 1. С. 34–41.

<sup>11</sup> Грибан Г. П., Ткаченко П. П., Скорий О. С., Пилипчук П. Б. Розвиток фізичних якостей в освітньому процесі здобувачів закладів вищої освіти. Житомир: Поліський національний університет, 2025. 44 с.

<sup>12</sup> Гогоць В. Д., Остапова О. О., Остапов А. В. Розвиток витривалості і сили: метод. посіб. Полтава, 2010. 36 с.

explosive strength. Rest intervals ensure improved performance in speed and strength endurance exercises<sup>13</sup>.

Circuit training represents a comprehensive, independent organizational and methodological form of training and, at the same time, is not limited to any single method. It includes a number of specific, strictly regulated exercise methods with selective and general effects on the body of those involved<sup>14</sup>.

Circuit training using the continuous work method is performed without breaks and consists of several repetitions of the circuit, depending on the number of stations. It has the following variations:

Variation 1. Exercises are performed without breaks during the complex and between circuits. After mastering an exercise and conducting a test to determine the maximum number of repetitions (maximum test – MT), each person receives a standard dose of MT/2 or MT/4. Exercises at each station and the transition between them are performed at a free pace, without time constraints. Increased load occurs by increasing the repetitions by one or two at each station (MT/2 +1) or by moving to the next more difficult complex<sup>15</sup>.

Variation 2. Exercises are performed without breaks, but with a target time. After mastering the exercises at each station, a maximum test (30 exercises and 30 seconds of rest) is completed, and the training time for completing a single circuit with a MT/2 or MT/4 dose is recorded. The time to complete one circuit, multiplied by the number of circuits (depending on the number of stations), yields the target time. With a standard volume of exercises, trainees should strive to reduce their circuit times to the target time. Increased intensity is achieved by setting a new maximum test or moving on to a more challenging routine. An achievement card is created for this purpose<sup>16</sup>.

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<sup>13</sup> Шемчак І. А. Використання колового тренування в процесі підготовки спортсменів. *Матеріали XLVII науково-технічної конференції підрозділів Вінницького національного технічного університету*: збірник доп. (м. Вінниця, 13-14 березня 2018 р.). Вінниця: ВНТУ, 2018. С. 793–795.

<sup>14</sup> Сиротинська О. К., Чеховська А. Ю. Колове тренування як дієвий засіб для гармонійного фізичного розвитку здобувачів вищої освіти. *Rehabilitation and Recreation*. 2023. №14. С. 236–241. <https://doi.org/10.32782/2522-1795.2023.14.28>

<sup>15</sup> Терещенко В. І., Полухін Ю. В., Коропатов Б. М., Козлова К. П. Організація навчальних занять з фізичного виховання за методом колового тренування. *Науковий часопис Українського державного університету імені Михайла Драгоманова. Серія 15*. 2021. Вип. 11(143). С. 142–144. [https://doi.org/10.31392/NPU-nc.series15.2021.11\(143\).3](https://doi.org/10.31392/NPU-nc.series15.2021.11(143).3)

<sup>16</sup> Борисенко Н. В. Методичні рекомендації до організації самостійної роботи та проведення практичних занять із навчальної дисципліни «Фізичне виховання». Методика проведення колового тренування (для всіх освітніх програм Університету). Харків: ХНУМГ ім. О. М. Бекетова, 2019. 46 с.

Variation 3. Exercises are performed without breaks, with a standardized training time and a standard number of repetitions, but with varying numbers of circuits. After the exercises have been learned and the MT at each station has been determined using the principle of 30 seconds of work, 30 seconds of rest, the workout is performed with a standard training time. The dosage and time for each circuit remain standard, but the number of circuits increases. The minimal time required for this option allows for circuit training to be incorporated into virtually every session<sup>17</sup>.

All circuit training variations using the continuous exercise method can be used in sports, general physical training, and wrestling<sup>18</sup>. Circuit training, organized using the interval exercise method with strict rest intervals, is performed with short breaks, so-called «action» pauses, both between exercises and between circuits. The main components of the load in this type of circuit training are: the duration and tempo of the exercise, the weight, the number of sets per station and circuits completed, and the duration of rest intervals between sets at the station, stations, and circuits<sup>19</sup>.

M. Scholikh offers three variations of this method. In the first and second exercises, the stations are 15 seconds long with a constant rest period of 30–45 seconds. Circuit training in this variation is structured as follows: training with an individual dose of MT/2 for 15 seconds with rest intervals of 45 seconds<sup>20</sup>. Rest time depends on the intensity of the chosen exercise and the physical fitness of the participants. The higher the intensity of the exercise, the more successful the development of maximum strength, as well as physical qualities such as power and speed endurance<sup>21</sup>. When performing circuit training in the first and second variants, it is important to ensure precise execution of the exercises at an average training pace. Overdoing it with maximum tempo at the expense of precision is unacceptable<sup>22</sup>.

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<sup>17</sup> Ціпов'яз А. Т., Христова Т. Є., Антонова О. І. Практичні методи фізичного виховання та реабілітації : навч. посіб. Кременчук : Кременчужський національний університет імені Михайла Остроградського, 2013. 140 с.

<sup>18</sup> Онопрієнко О. В. Теорія і методика розвитку рухових якостей : навч.-метод. посіб. Черкаси: ЧНУ імені Богдана Хмельницького, 2008. 92 с.

<sup>19</sup> Опанасюк Ф. Г., Грибан Г. П. Основи розвитку фізичних якостей студентів : навч.-метод. посіб. Житомир, 2006. 332 с.

<sup>20</sup> Scholikh Manfred. Circuit Training: Perfect Fitness Program for All Sports. Sport Books Publisher, 2001. 254 p.

<sup>21</sup> Антіпова Ж. І. Барсукова Т. О., Гоголева О. М. Розвиток гнучкості у студентів закладів вищої освіти: метод. реком. Одеса: видавець Букаєв Вадим Вікторович, 2021. 54 с.

<sup>22</sup> Єсіонова Г. О., Нерушенко Є. В., Кушнір Г. Г. Фізичне виховання: гнучкість і методика її розвитку: навч.-метод. посіб. для студ. усіх напрямів підготовки освітньо-кваліфікаційного рівня «бакалавр». Запоріжжя: ЗНУ, 2012. 70 с.

In the third variation, they exercise at the stations for 30 seconds with a constant 30-second break. When selecting the third option, it's necessary to consider sets of exercises that trainees can perform for 30 seconds without rushing and with acceptable precision. In the third option, the individual load is increased by increasing the number of repetitions at the stations (MT + 1/2, MT + 2/2, and so on), and the overall load is increased by increasing the number of circuits completed by the entire group<sup>23</sup>.

Circuit training using interval training with full rest intervals is characterized by rest periods that are relatively sufficient to fully restore performance. Depending on the weight, pace and duration of the workout, and the number of muscles involved, rest intervals can range from 1.5–2 minutes to 4–5 minutes. Circuit training using this method primarily utilizes strength and speed-strength exercises<sup>24</sup>.

The volume of the training load is adjusted by varying the number of repetitions, the time spent at each station, and the number of stations or circuits performed. By changing the weight and tempo of the work, the muscle contraction pattern changes, and consequently, the training effect achieved<sup>25</sup>.

Overcoming near-limit and maximum resistance is a powerful factor in developing muscle strength. It is contraindicated when working with young athletes. In some cases, resistance close to the maximum resistance may be used when training highly skilled athletes.

The effectiveness of strength exercises is greater the closer the strength development conditions in the training and main exercises are.

The following circuit training variations are of particular interest.

Option 1. A circuit routine is created, the maximum result in each exercise is determined, and the work time is set at 15 seconds. A weight is then selected that allows 8–12 repetitions to near failure in 15 seconds. The load volume is increased by adding stations in the circuit from 6–8 to 10 and increasing the number of circuits completed from one to three. Improved fitness is achieved by reducing the time spent at each station while maintaining a constant number of exercise repetitions.

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<sup>23</sup> Гуреева А. М., Дорошенко Е. Ю., Сазанова І. О. Фізичне виховання та здоров'я: методика розвитку гнучкості: навч. посіб. Запоріжжя: Запорізький державний медичний університет, 2019. 88 с.

<sup>24</sup> Касарда О. З., Захожа Н. Я., Захожий В. В., Савчук С. І., Галицька А. Б. Розвиток фізичних якостей та відновлення психоемоційного здоров'я здобувачів освіти : метод. реком. Луцьк, 2024. 58 с.

<sup>25</sup> Линець М. М. Основи методики розвитку рухових якостей: навч. посіб. Львів : Штабар, 1997. 208 с.

Option 2. This option involves performing exercises in series at each station and metering the load by the number of repetitions. If the total time spent at each station does not decrease, the maximum result in each exercise is determined and a new training weight is selected.

Option 3. Increased load is achieved by increasing the number of stations and circuits completed and reducing the time spent performing the exercises.

Option 4. Increase the total number of repetitions within a given time spent at each station.

Option 5. Reduce the total time it takes to complete a given number of exercise repetitions.

In the last three variations, the load is determined by the repetition maximum (RM) or the maximum number of repetitions of a movement with a given weight. If the work time does not decrease or the number of repetitions does not increase with the established number of exercise repetitions, a new load is determined based on the repetition maximum or as a percentage of the maximum result for the exercise.

All variations contribute to increasing maximum strength, explosive power, and strength endurance. They can be used in sports development programs.

Let's look at some variations of «circuit training»:

«Continuous Exercise Method». In this variation, there are no breaks between exercises. Exercises can be conducted in two ways:

a) Students complete one or more «circuits» without limiting the total time spent «per circuit» The load in each exercise is relatively light – MR/2 or even MR/4. It can be gradually increased by increasing the number of repetitions or by increasing the weights used;

b) Students complete 1-3 «circuits» with a time limit and recording. Typically, students fail to meet the time limit at first, but then, as their fitness improves, they meet the limit. After this, a repeat MR test is conducted, and the total «circuit» time is set again. In this case, the load can be increased in several ways:

1) by decreasing the time spent completing a circuit by 30–60 seconds at each session;

2) keeping the total time constant, but increasing the number of repetitions of each exercise;

3) keeping the total time and number of repetitions unchanged, but increasing the number of exercises.

«Continuous Circulation» is aimed primarily at developing general and strength endurance.

**«Interval Exercise Method».** This variation of «circuit training» involves breaking the training load during a session into separate, timed «chunks» This increases the effectiveness of the exercises on the trainee's body.

The duration of each exercise is 10-15 seconds, the pause between exercises is 30-90 seconds, and the pause between «circuits» is 2–5 minutes.

When designing a session according to this principle, various options are also possible:

a) the duration of the set is limited by time (e.g., 30 seconds). During this time, each student must complete the maximum number of repetitions. If this number exceeds 25–30, the weight must be increased or the exercise conditions must be made more challenging;

b) the duration of the set is also limited by time, but the student performs an optimal number of repetitions at a relatively leisurely pace, rather than the maximum;

c) the duration of the set is limited by the number of repetitions (e.g., 20 or 25 in each exercise).

In the last two options, the dosage of the weights used can be determined based on the "repetition maximum" values.

The "interval exercise method" offers the instructor and student the widest range of training options.

The types and variations of circuit training discussed here only characterize, but are far from exhaustive, all the variations that have become widespread in physical education and sports training.

## **2. Development of physical qualities using circuit training**

At all stages of circuit training, direct and feedback communication is maintained between the instructor and student, with strict monitoring of physical development and health<sup>26</sup>. Physical education is a multifaceted, long-term process, and it is organically linked to the development of physical qualities, primarily strength, speed, flexibility, endurance, and agility.

By incorporating strength exercises into circuit training programs, significant gains and increases in strength can be achieved through the rational modeling of strength-related work<sup>27</sup>.

Muscular strengthening is achieved by developing the ability to exert force in basic work modes: dynamic, static, strength-based, and speed-based, as well as by developing the ability to correctly use force in a variety of work environments within the chosen profession<sup>28</sup>. Along with strength,

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<sup>26</sup> Грибан Г. П., Ткаченко П. П., Скорий О. С., Пилипчук П. Б. Розвиток фізичних якостей в освітньому процесі здобувачів закладів вищої освіти. Житомир : Поліський національний університет, 2025. 44 с.

<sup>27</sup> Онопрієнко О. В. Теорія і методика розвитку рухових якостей : навч.-метод. посіб. Черкаси: ЧНУ імені Богдана Хмельницького, 2008. 92 с.

<sup>28</sup> Опанасюк Ф. Г., Грибан Г. П. Основи розвитку фізичних якостей студентів : навч.-метод. посіб. Житомир, 2006. 332 с.

circuit training stations can also successfully develop endurance, which is developed through the ability to withstand heavy loads and fatigue<sup>29</sup>.

An equally important quality, speed of movement, can also be incorporated into the model and successfully developed at circuit training stations<sup>30</sup>. Speed of movement has great practical significance. Modern technology places high demands on speed and certain forms of its manifestation: speed of motor reaction, frequency of movement, etc.<sup>31</sup> One of the main ways to develop agility at circuit training stations is the acquisition of new, varied motor skills and abilities<sup>32</sup>.

Circuit training stations utilize exercises at maximum speed (usually referred to as speed exercises) as a means of developing speed. The repeated exercise method is widely used. Its main tendency is to encourage students to exceed their maximum speed in each subsequent session. All components of the load in speed exercises, namely, the distance, intensity of the exercises, rest intervals, and the number of repetitions, are subordinated to this<sup>33</sup>.

When selecting and composing a set of physical exercises for circuit training, the differences in the functional capabilities of girls and boys should be taken into account. Physical loads for girls should be less in both volume and intensity compared to those used in circuit training sessions with boys<sup>34</sup>.

An important distinguishing feature of developing physical qualities in girls during circuit training is the gradual increase in load-the number of stations, the volume of repetitions, the intensity of the exercises, etc. Therefore, with the right approach, circuit training should be aimed at developing the body, strengthening organs and systems, and increasing their functional capabilities<sup>35</sup>.

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<sup>29</sup> Касарда О. З., Захожа Н. Я., Захожий В. В., Савчук С. І., Галицька А. Б. Розвиток фізичних якостей та відновлення психоемоційного здоров'я здобувачів освіти : метод. реком. Луцьк, 2024. 58 с.

<sup>30</sup> Гурєєва А. М., Дорошенко Е. Ю., Сазанова І. О. Фізичне виховання та здоров'я: методика розвитку гнучкості : навч. посіб. Запоріжжя : Запорізький державний медичний університет, 2019. 88 с.

<sup>31</sup> Линець М. М. Основи методики розвитку рухових якостей : навч. посіб. Львів : Штабар, 1997. 208 с.

<sup>32</sup> Грибан Г. П., Ткаченко П. П., Скорий О. С., Пилипчук П. Б. Розвиток фізичних якостей в освітньому процесі здобувачів закладів вищої освіти. Житомир : Поліський національний університет, 2025. 44 с.

<sup>33</sup> Єсіонова Г. О., Нерушенко Є. В., Кушнір Г. Г. Фізичне виховання: гнучкість і методика її розвитку : навч.-метод. посіб. для студ. усіх напрямів підготовки освітньо-кваліфікаційного рівня «бакалавр». Запоріжжя : ЗНУ, 2012. 70 с.

<sup>34</sup> Онопрієнко О. В. Теорія і методика розвитку рухових якостей : навч.-метод. посіб. Черкаси : ЧНУ імені Богдана Хмельницького, 2008. 92 с.

<sup>35</sup> Опанасюк Ф. Г., Грибан Г. П. Основи розвитку фізичних якостей студентів : навч.-метод. посіб. Житомир, 2006. 332 с.

Exercises are selected based on the objectives of the session or training session. Ideally, a comprehensive workout routine should contain 10–12 exercises, while specialized workout routines should contain no more than 6–8. Exercises should be thoroughly studied. Students should know the names of each exercise and understand the symbols on the cards<sup>36</sup>.

As is well known, developing strength endurance should be based on exercises performed with a sufficiently high number of repetitions. To determine the number of repetitions and the weights used for each exercise, it is necessary to periodically (at least once every two weeks) conduct a maximum repetition test – determining the maximum repetition limit (MR)<sup>37</sup>.

**Strength Development.** Strength is a person's ability to overcome external resistance through muscular effort. Strength is developed through exercises that require significant muscle tension. Paired exercises and weighted exercises are beneficial.

Strength development methods are based on the principles of alternating weight training and rest periods, as well as the relationship between intensity and volume of load. There are three main methods for using weight training and resistance bands:

- a) working for a long period of time with light weights or resistance;
- b) working with light weights or resistance at maximum speed;
- c) working with weights or resistance near the maximum or ultimate weight and resistance.

The most effective way to develop strength is working with weights near the maximum or ultimate weight and resistance. Maximum effort can be developed for a short period of time, as the student's body is unable to withstand maximum muscle tension due to a lack of oxygen needed for energy conversion. After a maximum effort, a «full interval» of rest of 3–5 minutes is necessary to restore performance.

When working with light weights and resistance to failure, the training effect is primarily exerted by the final attempts, during which the nervous system is similar in nature to that which occurs when working with near-maximum weights. This must be emphasized so that students consciously approach the limits of their capabilities and strive to gradually expand them. Developing strength with light weights has its advantages. It allows for easy control over correct movements and breathing, eliminating

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<sup>36</sup> Гуреева А. М., Дорошенко Е. Ю., Сазанова І. О. Фізичне виховання та здоров'я: методика розвитку гнучкості : навч. посіб. Запоріжжя : Запорізький державний медичний університет, 2019. 88 с.

<sup>37</sup> Касарда О. З., Захожа Н. Я., Захожий В. В., Савчук С. І., Галицька А. Б. Розвиток фізичних якостей та відновлення психоемоційного здоров'я здобувачів освіти: метод. реком. Луцьк, 2024. 58 с.

excessive muscle tension and straining, which is especially important when working with women.

To develop dynamic strength at circuit training stations, it is preferable to use exercises with relatively light weights at a moderate tempo and a high number of repetitions.

The effectiveness of strength exercises using circuit training largely depends on how efficiently the load is programmed and distributed during each session and individual cycle, as well as on the correct choice of weight and resistance of shock absorbers or expanders. An exercise program should be designed to alternately challenge all major muscle groups. Some exercises should be general in nature, others should be targeted, focusing on a specific muscle group, and still others should be specific, related to specific program material.

Avoid trying to perform as many different strength exercises as possible during circuit training. Exercises requiring greater effort should be alternated with exercises requiring less effort.

The most effective strength exercises for students are those that can be performed no more than 25 times in a row at one circuit training station for 30 seconds. If an exercise can be performed more times in a row, it will develop strength endurance rather than strength. Strength exercises are most effective when used at the beginning or middle of the main part of the workout. In this case, they are performed against a background of optimal central nervous system health, which facilitates the development and refinement of neurocoordination interactions that ensure increased muscle strength. Breathing is crucial during strength training and requires careful regulation. To avoid undesirable effects during strength training, the following basic rules should be followed:

- 1) strain only during short, maximum exertions;
- 2) include exercises at or near maximum exertion in small volumes during circuit training;
- 3) avoid taking a full breath before strength training, as this exacerbates the undesirable changes in the body caused by holding the breath;
- 4) it is advisable for students to inhale and exhale mid-exercise, despite the inconvenience of doing so, as it impedes breathing.

***Developing speed.*** Speed is the ability to perform a specific task in the shortest possible time without fatigue.

In the process of cultivating speed of movement, it is necessary to comprehensively enhance the body's functional capabilities. The maximum speed a person can exhibit when performing any movement depends not only on the development of speed, but also on a number of other factors – dynamic strength, flexibility, technical mastery, etc.

Speed, if expressed in the maximum frequency of movements, depends on the speed of transition of the motor nerve centers, from a state of excitation to a state of inhibition and back, i.e., on the flexibility of neural processes. Simple reactions are characterized by a very high transfer of speed.

Some people who react quickly in some situations also react quickly in others. Various specialized physical exercises improve the speed of simple reactions. Developing speed at circuit training stations consists of developing students' abilities to perform rapid movements and quick motor reactions. When developing complex motor reactions at circuit training stations, the number of possible changes in the game environment is gradually increased.

The primary method for developing speed is repeated movements at maximum speed. The duration of such exercises is determined by the time during which maximum speed can be maintained. Exercises aimed at developing speed of motor reactions are also a good means of training the speed of individual movements.

To increase movement speed, it is necessary to develop both muscle strength and movement speed. The latter is achieved by incorporating light-weight exercises into circuit training so that students consciously develop and increase their strength during class.

In cyclic sports such as track and field, swimming, rowing, and others, speed is primarily reflected in the frequency of movements. To maintain a high tempo of movement, muscles must contract and relax quickly. This is achieved through the regular use of exercises in circuit training performed as frequently as possible without undue strain.

Therefore, the primary means of developing speed in cyclic movements is repeated exercises at the fastest or highest tempo, as well as acceleration exercises performed at different stations and repeated every 1-3 stations. In some cases (when a speed barrier arises), it is advisable to temporarily discontinue speed-building exercises and switch to other types of exercises that can improve the development of speed-strength qualities. In addition to direct work on speed, specific exercises aimed at improving the abilities and skills that determine overall performance speed should be widely used. For this purpose, stations utilize speed-strength exercises involving stretching and relaxation, as well as exercises structured around speed.

From a psychological perspective, the manifestation of speed depends largely on the students' motivations for practicing a particular exercise at the station. Therefore, it is advisable to consider the use of a competitive or game-like method for completing exercises and to set specific goals for the trainees.

***Developing dexterity.*** Dexterity is the ability to quickly master new movements and quickly adapt motor activity to the demands of a suddenly changing environment.

This quality is developed through the performance of complex gymnastic exercises and acrobatic jumps. The coordination challenges that the student must overcome gradually increase. These challenges are compounded by the demands placed on the precision of movements, their mutual coordination, and the suddenness of changes in the environment. Developing dexterity is a requirement common to all professions, and its specific nature requires a specialized selection of tools based on the specific nature of the students' future activities.

Programmed development of dexterity at circuit training stations is based on enriching students with new and varied motor skills and abilities. The greater the student's motor skills and abilities, the richer their motor experience and the broader the basis for acquiring new forms of motor activity.

Developing dexterity at circuit training stations is associated with improving the functions of various analyzers, primarily the motor system. Exercises that contain novel elements and present students with a specific coordination challenge can effectively improve the functional development of the motor analyzer and, consequently, dexterity. Three main stages are distinguished in developing dexterity: the first is characterized by the improvement of spatial precision and motor coordination, regardless of the speed at which the exercises are performed; the second stage is characterized by the development of spatial precision and motor coordination that can be performed in compressed periods of time, efficiently and precisely; the third stage is a complication of the second and is associated with the refinement of the ability to perform precise movements in unexpectedly changing conditions.

In different professions, as in different types of motor activity, dexterity is manifested and developed differently. The following main areas of dexterity development are distinguished:

1) Dexterity demonstrated in exercises that involve changing postures. For example, quickly sitting, lying down, and standing.

2) Dexterity demonstrated in exercises performed in complex, changing conditions. For example, overcoming obstacle courses, various climbing exercises, etc.

3) Dexterity demonstrated in exercises with changing resistance. These include tug-of-war, resistance exercises, martial arts-type exercises, etc.

4) Dexterity demonstrated in exercises that involve manipulating objects. These include throwing and catching various objects.

5) Dexterity demonstrated in exercises that require the coordinated efforts of several participants. These are performed in collaboration with a partner, in both simple and complex actions.

6) Dexterity demonstrated in game-like exercises that require interaction and resistance. These include dribbling objects and a partner, intercepting a pass that bounces off a wall, etc.

One aspect of agility is the ability to maintain a stable body position while performing various movements on limited surfaces, known as dynamic and static postural balance. Balance training in circuit training is accomplished in two main ways.

The first is based on exercises that involve movements and postures that make maintaining balance difficult. These include various types of balance on two or one leg, moving forward or backward by walking, running, or jumping; various climbing exercises; movements and postures on reduced support; exercises for landing stability after various jumps; balancing various objects; and more.

The second method aims to improve vestibular function. All exercises included in circuit training that involve rotation of the head, limbs, and torso in various planes are beneficial in this regard. These include somersaults, somersaults, pirouettes, or combination exercises combining a variety of the above exercises. Work on developing and improving agility should be carried out continuously in all physical education classes.

***Developing Endurance.*** Endurance is the ability to resist fatigue in any activity. To overcome fatigue, cultivating willpower and the ability to force oneself to continue working at the required intensity despite difficulties is crucial.

Endurance is the ability to perform work at a given intensity for as long as possible, overcoming resistance from both the external and internal environment.

The ability to perform prolonged, uninterrupted work at moderate intensity, engaging all muscles of the musculoskeletal system, characterizes general endurance. The main principle of developing general endurance at circuit training stations is a gradual increase in physical exercises of varying intensity, engaging as much muscle mass as possible. General endurance serves as the foundation for acquiring various types of specialized endurance.

Specific endurance is understood as the ability to maintain effective performance in a specific type of motor activity for a long period of time. Depending on the intensity of the work, the time it takes to complete it at circuit training stations will vary. The higher the intensity of the exercises at the stations, the shorter the time during which this speed can be maintained.

With regard to circuit training, the following main types of specialized endurance are distinguished: dynamic strength endurance (strength endurance); static strength endurance; and speed-dynamic endurance (speed endurance).

Strength endurance is the ability to perform dynamic work for extended periods of time, requiring significant neuromuscular effort. It is developed through weight training, overcoming your own weight and the weight of a partner, exercises with various resistances, etc.

These exercises are used in circuit training based on the principle of gradual progression. Initially, the load is increased by gradually increasing the volume of training by increasing the number of strength stations, then by increasing the intensity of the exercises by increasing the number of repetitions at each station. Students are tasked with achieving as many repetitions as possible at each station. Physical activity recommendations for specific genders and ages are differentiated for strong, moderate, and weak athletes.

Static endurance is the ability to maintain muscle tension without movement. It is developed through exercises involving hanging, support, or holding weights, etc.

To develop endurance for static efforts, isometric exercises are useful. The intensity of tension in these exercises should not be maximal, and the duration should be short. These exercises include exercises for holding and fixing certain poses with or without additional weights, as well as performing dynamic exercises while holding these poses. This includes individual exercises aimed at strengthening the shoulder girdle, abdominal muscles, arms and hands, which are useful to include in morning exercise routines.

The most effective means of developing speed endurance at circuit training stations is sprinting with gradually increasing segment lengths, as well as various jumping and throwing exercises. At circuit training stations, attention must also be paid to improving movement speed and reaction time. General and specific endurance in circuit training exercises is developed through regular sessions at least twice a week. Initially, this is done by gradually increasing training time through a large number of exercises performed at the stations in a complex manner, and then by increasing intensity and speed.

In addition to developing general endurance through circuit training, it is essential to develop specific game-specific endurance through various game exercises. Such varied and repetitive activity requires rapid switching of physiological functions from one level to another, as well as high plasticity and flexibility of the central nervous system. Improving «game endurance» is achieved by increasing the number of game-oriented circuit training stations, increasing the intensity of exercises, or the number of circuits completed while gradually increasing the difficulty of the exercises.

In exercises borrowed from martial arts, specific endurance is developed by increasing the number of exercises performed at circuit training stations, progressing to more complex exercises, and increasing the number of sessions per week.

Specific strength endurance is developed through strength training exercises at a moderate pace with weights equal to approximately 50% of the maximum. It is also recommended to alternate between heavy and light loads. When using speed-strength exercises, the usual weight should be increased gradually, after students' bodies have adapted to previous loads.

Increasing specific endurance is closely linked to improving athletic technique. Therefore, the duration of any specific work will depend not only on general endurance but also on the degree of technical perfection. The higher the technical perfection, the less unnecessary movements and tension the student experiences, and consequently, the less wasted energy. High technique is especially important in developing endurance at circuit training stations, in paired exercises in martial arts, and in exercises with balls and other objects or equipment.

Systematic circuit training increases endurance several-fold. But to achieve this, students need to study systematically and for a long time, gradually increasing both the workload at the stations and the number of laps completed throughout the academic year.

***Developing Flexibility.*** Flexibility is defined as the properties of the musculoskeletal system that determine the degree of mobility of its components. Flexibility is measured by the maximum range of motion.

Flexibility should be developed only to the extent necessary to allow the required movements to be performed without hindrance. This flexibility should slightly exceed the maximum range of motion (the «flexibility reserve»). Excessive development of flexibility will cause harm.

Flexibility is the ability to perform movements with a large range of motion. It is essential for industrial activities and various blue-collar jobs that require a certain, often large, range of motion-i.e., a flexibility reserve. On the other hand, exercises that develop flexibility simultaneously strengthen joints and ligaments, increase muscle elasticity, and enhance their ability to stretch, which is a very important factor in preventing muscle injuries at work.

Women tend to have greater flexibility than men. Good flexibility allows for more complete professional development, agility, and increased productivity. A distinction is made between general and specialized flexibility. General flexibility is the range of motion in all joints, allowing for a wide range of work-related and athletic movements. Specific flexibility is significant or even extreme range of motion in the joints involved in professional activities or specific sports.

To develop flexibility, exercises that increase range of motion are used. The ability to perform movements with a large range of motion depends largely on the shape of the articular surfaces, the flexibility of the spinal column, and the extensibility of the ligaments, tendons, and muscles.

However, individual differences in joint structure can limit movement or, conversely, allow for increased range of motion. The maximum range of motion allowed by the joint structure is generally limited to a certain extent by the ligaments and muscles. The more elastic the ligaments, the less this limitation. Through systematic exercise, it is possible to significantly increase the elasticity of the ligamentous apparatus, and therefore, joint mobility. Flexibility in the joints of the spinal column is usually sufficient for performing most work-related and physical exercises.

If, in the created circuit training model, exercises are selected only for strength development, while ignoring the need to maintain muscle extensibility and joint mobility, the results will always be poor. At the circuit training stations, programmed strength exercises should be used in parallel, alternating with flexibility exercises. This approach yields the best results and is proven effective.

Running is essential at the beginning of circuit training to warm up the muscles, as muscle temperature is a key factor determining its stretchability. An increase in body temperature, either due to external heat or physical work, increases muscle blood flow, making the fibers more elastic. High overall joint mobility is acquired through the numerous and varied exercises at the circuit training stations. Among the general development exercises, many promote joint mobility. These include various bends, rotations, swings, and the like, performed with the widest possible range of motion.

Specific joint mobility is acquired through exercises at stations that primarily focus on stretching or flexibility.

Flexibility exercises can be active or passive, meaning they can be performed independently, with the help of a partner, or with weights. Active exercises are divided into those performed without weights and those performed with weights (dumbbells, medicine balls, barbells, etc.).

Flexibility exercises are performed at circuit training stations at varying speeds: slowly for less-trained students and quickly for more-trained ones.

At circuit training stations, weights are used, firstly, to increase the load, secondly, to increase the range of motion (through momentum), and thirdly, to create a stretching effect on the tense muscle.

Weighted exercises are more effective than other exercises. Weights for developing flexibility should be used with caution, especially when the exercise is performed quickly or in cold weather on a sports field. Passive exercises, involving partner-assisted movements, are also used in developing flexibility at circuit training stations.

Stretching exercises should be performed with gradually increasing range of motion. Particular caution should be exercised when increasing range of motion in passive exercises and outdoor weight training. To achieve a

greater range of motion in specialized exercises, it is advisable to use some kind of target (touching the bar with the toe of the swinging leg, etc.).

Flexibility development at circuit training stations should always be programmed in conjunction with strength development.

Exercises with increased range of motion (stretching exercises) are used to develop flexibility. These are divided into two groups: active movements and passive ones. Particular attention should be paid to developing mobility in the hip and shoulder joints, as well as in the joints of the hands and ankles. Flexibility exercises include: gymnastic exercises without an apparatus; paired exercises; with a medicine ball; with an expander and shock absorber.

## CONCLUSIONS

The analyzed material reveals circuit training in detail as a universal and highly effective organizational and methodological form that enables the comprehensive and targeted development of fundamental physical qualities. Unlike static methods, CT ensures high motor density during training and allows for flexible load dosing, adapting it to the individual fitness level of trainees based on the maximum test and repetition maximum.

Circuit training is based on three key methods, each with a clear physiological focus. The first is the continuous flow method, which involves performing exercises continuously, without pauses or with minimal rest intervals between stations. Its various variations (for example, with dosing based on the maximum test of MT/2 or MT/4, as well as with target or standardized time) are aimed primarily at the comprehensive development of motor skills and general and strength endurance. The second method is the flow-interval method (with hard pauses), which is characterized by short work periods (usually 15-40 seconds) with regulated rest periods (30-45 seconds). This regimen utilizes so-called «effective» pauses and effectively impacts strength endurance and improves the respiratory and cardiovascular systems. Finally, the third method is the intense interval method (with full pauses), which is used to develop maximal and explosive strength. The intensity of the exercises reaches up to 75% of the maximum, and the duration of rest (up to 4–5 minutes) ensures relatively complete recovery between sets, which is a prerequisite for working with near-limit and maximum weights.

Circuit training is a powerful tool for selectively developing each of the fundamental physical qualities. Strength is developed through exercises that exert significant muscular tension, using either light weights at maximum speed or near-maximum weights with full rest intervals. Alternating loads on different muscle groups, proper breathing, and differentiated dosages for male and female students are essential. Speed is developed through repeated movements at maximum speed and is aimed at increasing the frequency of movements and the speed of motor reactions. This is achieved by

incorporating light weight exercises, speed drills, and acceleration-type exercises performed every 1-3 stations. Agility is developed through mastering new, varied motor skills and performing exercises that require high coordination complexity (e.g., gymnastics and acrobatic elements). A gradual increase in coordination difficulty is important, including in unexpectedly changing conditions typical of game exercises. Finally, endurance is developed in two ways: general endurance is achieved by gradually increasing the duration of training (through the number of stations and circuits), while specific endurance (strength, speed) is developed through the use of appropriate interval methods and specialized exercises.

Circuit training is a flexible, variable, and scientifically proven form of training organization that, when properly applied, allows for maximum training effect and the targeted development of all vital physical qualities.

### **SUMMARY**

The article considers the main methods and options for applying circuit training in the physical education of students. Three basic methods are analyzed – continuous-current, current-interval and intensive-interval, each of which is aimed at developing individual motor qualities: general and strength endurance, maximum strength, «explosive» strength and speed-power capabilities. Variants of building training sessions that differ in duration, number of stations, rest mode and methods of increasing the load are described in detail. It is determined that circuit training is an effective organizational and methodological form of training that provides comprehensive physical development due to the rational alternation of exercises of different orientations. The possibilities of targeted development of physical qualities – strength, speed, endurance, agility and flexibility – by means of circuit training are substantiated. Practical recommendations are given on the differentiation of physical exertion for boys and girls, methods of control and gradual increase in training load. The results of the study confirm that the systematic use of circuit training contributes to increasing the functional capabilities of the body, developing basic motor skills, and forming a sustainable motivation for physical education.

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