# Improving the development of physical qualities in university students through a differentiated circuit training program

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**Abstract:** The article addresses the problem of developing the basic physical qualities of university students under conditions of declining motor activity. The aim of the study was to substantiate and experimentally verify the effectiveness of a differentiated circuit training program for developing the physical qualities of first-year students. The pedagogical experiment lasted one academic semester (16 weeks, two 80-minute sessions per week) and involved 60 first-year male students of Almalyk State Technical Institute, divided into an experimental group (n=30) and a control group (n=30). Physical fitness was assessed using a battery of six motor tests evaluating speed, speed-strength qualities, strength, endurance, flexibility and coordination. The results were processed using Student's t-test. By the end of the experiment, the experimental group demonstrated statistically significant improvements in all six indicators, considerably exceeding the gains of the control group, in which the changes were statistically insignificant. The findings confirm that a differentiated circuit training program is an effective pedagogical means of developing the physical qualities of university students and can be recommended for inclusion in the physical education curriculum of higher educational institutions.

**Keywords:** physical qualities, physical education, university students, circuit training, differentiated approach, motor fitness, pedagogical experiment, strength, endurance, flexibility

## Introduction

Strengthening the health of young people and forming a physically active, harmoniously developed generation is among the priority directions of state policy of the Republic of Uzbekistan in the sphere of education and physical culture [1; 11]. The student years coincide with the completion of biological maturation and the formation of stable lifestyle habits, which makes this period especially important for the purposeful development of physical qualities. At the same time, the modern educational process is characterized by a high intellectual load, prolonged static postures and a marked reduction of motor activity (hypodynamia), which negatively affects the physical fitness and health of students.

The level of development of the basic physical qualities - strength, speed, endurance, flexibility and coordination abilities - largely determines a person's general work capacity, resistance to fatigue, and readiness for professional and everyday activity [2; 3]. Therefore, the search for effective methods of developing these qualities within the limited time allotted to physical education classes (as a rule, two sessions per week) remains an urgent pedagogical task.

Among the variety of methods of physical education, circuit training occupies a special place. It allows the simultaneous, integrated development of several physical qualities, ensures a high motor density of the lesson, and is easily dosed and individualized [6; 8]. The effectiveness of circuit training increases considerably when it is combined with a differentiated approach, in which the magnitude of the training load is adjusted to the individual fitness level of each student. Such an approach makes it possible to provide every student with an adequate, optimal training stimulus and to avoid both insufficient and excessive loading [2; 5].

The aim of the present study is to substantiate and experimentally verify the effectiveness of a differentiated circuit training program for developing the basic physical qualities of first-year university students. It was hypothesized that the systematic application of such a program during one academic semester would lead to statistically significant improvements in the physical fitness of students, exceeding the results achievable through the traditional curriculum.

Materials and Methods

Organization of the study and participants. The pedagogical experiment was conducted during one academic semester of the 2024/2025 academic year on the premises of Almalyk State Technical Institute. The study involved 60 first-year male students aged 17-18 years, assigned to the basic medical group and having no contraindications to physical exercise. The participants were divided into two equivalent groups: an experimental group (EG, $n = 30$) and a control group (CG, $n = 30$). Preliminary testing confirmed the absence of statistically significant differences between the groups at baseline ($p > 0.05$), which indicates their initial homogeneity.

Content of the program. Students of both groups attended physical education classes twice a week (two 80-minute lessons). The control group exercised according to the standard physical education curriculum. In the experimental group, the main part of the lesson (35-40 minutes) was organized in the form of differentiated circuit training comprising 8-10 stations aimed at the consecutive development of strength, speed-strength, speed, coordination and endurance abilities. The load at each station was differentiated according to three sub-levels of fitness (low, medium, high), determined by the results of preliminary testing, by varying the number of repetitions, the duration of the work and rest intervals, and the magnitude of the external resistance. Throughout the semester the load was progressively increased (the principle of

progressive overload) by raising the number of circuits (from 2 to 4), shortening the rest intervals and increasing the intensity of the exercises [6].

Methods of assessment. To assess the level of physical fitness, a battery of six standardized motor tests was used: the 30 m sprint from a standing start (speed); the standing long jump (speed-strength qualities of the legs); pull-ups on a high bar (strength of the arms and shoulder girdle); the 1000 m run (general endurance); the seated forward bend, i.e. sit-and-reach (flexibility); and the 4×9 m shuttle run (coordination abilities and agility). Testing was carried out twice - before and after the experiment - under identical conditions.

Statistical analysis. The obtained data were processed using methods of mathematical statistics. For each indicator the arithmetic mean (M) and the standard deviation (σ) were calculated. The significance of differences was assessed using Student's t-test; differences were considered statistically significant at $p < 0.05$. Calculations were performed using Microsoft Excel and IBM SPSS Statistics. Participation in the study was voluntary; all students gave their informed consent and had valid medical clearance.

Results

The results of the pedagogical experiment are presented in Tables 1 and 2. At the beginning of the experiment, the indicators of physical fitness in the experimental and control groups did not differ significantly ($p > 0.05$), which confirms the equivalence of the groups.

As shown in Table 1, by the end of the experiment the students of the experimental group demonstrated a statistically significant improvement in all six tested indicators ($p < 0.05$). The most pronounced relative gains were observed in flexibility (the sit-and-reach result improved by 69.1%) and in strength (the number of pull-ups increased by 44.2%). Speed-strength qualities (the standing long jump) improved by 7.5%, general endurance (the 1000 m run) by 7.2%, speed (the 30 m sprint) by 4.9%, and coordination (the 4×9 m shuttle run) by 4.7%.

*Table 1*

Dynamics of physical fitness indicators in the experimental group (n = 30)

| Motor test | Unit | Before (M ± σ) | After (M ± σ) | Gain, % | t | p |
|---|---|---|---|---|---|---|
| 30 m sprint | s | 4.92 ± 0.21 | 4.68 ± 0.18 | 4.9 | 4.78 | < 0.05 |
| Standing long jump | cm | 218.4 ± 9.6 | 234.7 ± 8.9 | 7.5 | 6.82 | < 0.05 |
| Pull-ups | reps | 8.6 ± 2.1 | 12.4 ± 2.3 | 44.2 | 6.69 | < 0.05 |
| 1000 m run | s | 232.5 ± 11.3 | 215.8 ± 9.7 | 7.2 | 6.15 | < 0.05 |
| Sit-and-reach | cm | 6.8 ± 2.4 | 11.5 ± 2.6 | 69.1 | 7.26 | < 0.05 |
| 4×9 m shuttle run | s | 10.12 ± 0.34 | 9.64 ± 0.29 | 4.7 | 5.88 | < 0.05 |

*Note. For the 30 m sprint, the 1000 m run and the 4×9 m shuttle run, lower values indicate better results; the percentage reflects the magnitude of improvement.*

In the control group (Table 2), positive changes were also recorded across all indicators; however, in none of the tests did these changes reach the level of statistical significance ($p > 0.05$). The relative gains in the control group did not exceed 12.7% (flexibility) and were considerably smaller for the remaining indicators (1.0-9.0%).

*Table 2*

Dynamics of physical fitness indicators in the control group (n = 30)

| Motor test | Unit | Before (M ± σ) | After (M ± σ) | Gain, % | t | p |
|---|---|---|---|---|---|---|
| 30 m sprint | s | 4.90 ± 0.22 | 4.85 ± 0.20 | 1.0 | 0.92 | > 0.05 |
| Standing long jump | cm | 219.1 ± 9.4 | 222.3 ± 9.1 | 1.5 | 1.34 | > 0.05 |
| Pull-ups | reps | 8.9 ± 2.0 | 9.7 ± 2.2 | 9.0 | 1.47 | > 0.05 |
| 1000 m run | s | 230.9 ± 10.8 | 228.4 ± 10.5 | 1.1 | 0.91 | > 0.05 |
| Sit-and-reach | cm | 7.1 ± 2.3 | 8.0 ± 2.5 | 12.7 | 1.45 | > 0.05 |
| 4×9 m shuttle run | s | 10.08 ± 0.33 | 9.95 ± 0.31 | 1.3 | 1.57 | > 0.05 |

*Note. For the 30 m sprint, the 1000 m run and the 4×9 m shuttle run, lower values indicate better results; the percentage reflects the magnitude of improvement.*

A comparison of the final results of the two groups revealed statistically significant differences in favour of the experimental group in all six tests ($p < 0.05$), which indicates the higher effectiveness of the proposed differentiated circuit training program in comparison with the traditional curriculum.

Discussion

The results obtained convincingly demonstrate the advantage of the differentiated circuit training program over the traditional physical education curriculum in developing the basic physical qualities of university students. The marked superiority of the experimental group can be explained by several factors. First, the circuit form of organization ensures a high motor density of the lesson and allows the simultaneous, integrated development of several physical qualities within a limited time [6]. Second, the differentiation of the load according to the individual fitness level made it possible to provide each student with an adequate, optimal training stimulus - sufficient to elicit adaptive changes yet not excessive - which is consistent with the fundamental principle of correspondence between the load and the functional capabilities of the body [2; 3].

The especially large relative gains in flexibility and strength are explained by the comparatively low initial level of these qualities among the students and by their high trainability under conditions of regular, targeted exposure. The significant improvement in endurance and speed-strength indicators reflects the favourable adaptive reorganization of the cardiovascular, respiratory and neuromuscular systems in response to systematic interval-type loading [5; 6]. These findings are consistent with the data of other researchers who have noted the high effectiveness of circuit training when working with student contingents [8; 9].

The positive but statistically insignificant changes in the control group indicate that the traditional curriculum, while maintaining the achieved level of fitness, does

not provide a sufficient training effect for the pronounced development of physical qualities over one semester.

Among the limitations of the study are the relatively short duration of the experiment (one semester), the participation of male students only, and the data being obtained at a single institution. Further research is advisable to verify the effectiveness of the program over a longer period, on a larger and mixed-sex sample, and to study the dynamics of the functional state of students in greater detail.

Conclusion

1. The conducted pedagogical experiment confirmed the effectiveness of the differentiated circuit training program for developing the basic physical qualities of first-year university students.

2. Over one academic semester, the students of the experimental group achieved statistically significant improvements in all six tested indicators ($p < 0.05$), considerably exceeding the results of the control group, in which the changes were statistically insignificant ($p > 0.05$).

3. The differentiated circuit training program can be recommended for wider use in the physical education process of higher educational institutions as an effective and time-efficient means of developing the physical qualities and improving the overall physical fitness of students.

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