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Effects of swimming and running training on the physical condition and working capacity of students

The study aimed to assess the effects of swimming and track running training on the physical condition, physical fitness level, health coefficient, and working capacity of students. The experiment involved 50 male students with a mean age of 20.16±1.4 years, studying at a pedagogical university in Uzbekistan. Over a three-year period, their physical condition was monitored using morphofunctional methods, physical working capacity was evaluated through the Harvard step test, and physical fitness was assessed with standard control exercises for the development of basic physical qualities. The health coefficient was calculated based on heart rate, blood pressure, body mass, height, and age. Data processing was performed using mathematical and statistical methods, including the calculation of arithmetic mean, standard deviation, and the Student's t-test to determine the significance of differences. The results showed a positive dynamic in the development of physical qualities and working capacity in both groups; however, swimming training led to more pronounced improvements across most measured indicators. The level of physical condition and the health coefficient increased to a greater extent in the swimming group compared to the running group. The findings confirm the high effectiveness of cyclic aerobic exercises, particularly swimming, for improving students' health and enhancing their functional capabilities.

Keywords: physical exercises, physical working capacity, physical fitness, physical condition, health coefficient.

Introduction

The improvement of physical fitness and the promotion of health among university students remains one of the key objectives of state policy in the Republic of Uzbekistan. In the context of the modernization of the higher education system, special attention is given to the development of a high level of physical fitness, sports skills, and commitment to a healthy lifestyle among students. However, despite the efforts undertaken, the level of physical activity among students remains insufficient. The decline in motor activity is associated with increased academic workload, changes in lifestyle, and insufficient integration of aerobic exercises into university educational programs [1–4].

The problem of decreasing physical activity among young people is of a global nature. Studies conducted in European countries, the United States, and Asia also report a trend towards reduced motor activity among students, largely linked to urbanization, technological development, and lifestyle changes [5, 6]. In a number of countries, efforts are being made to incorporate systematic aerobic activities, such as running and swimming into educational programs, which significantly improves physical condition, endurance, and functional resilience among young people [7, 8].

Considering the above, conducting a comparative analysis of the effects of swimming and track running on the physical condition of students in the context of the Republic of Uzbekistan appears to be a timely and relevant task aimed at developing effective health-promoting technologies within the higher education system.

Scientific literature reflects a diversity of physical education methodologies based on the application of various forms and means of physical activity [3, 6, 7]. Particular attention is given to cyclic types of exercises, such as walking, running, and swimming, due to their proven effectiveness in enhancing aerobic capacity.

Training processes based on the use of cyclic aerobic loads contribute to improved coordination of movements, development of endurance, reaction speed, strength, and overall physical working capacity among students [9, 10].

At the same time, a number of studies have been limited to comparing the effects of different types of exercises based on a small set of indicators or without considering the characteristics of the study participants, which complicates the formation of a comprehensive understanding of the effectiveness of various types of physical activity within the framework of health-oriented physical education [5, 9].

Current evidence indicates that achieving a sustainable health-promoting effect requires systematic training involving large muscle groups, rhythmic activity of moderate to high duration, and predominantly aerobic energy supply mechanisms (Thomas et al., 2020; Boltobaev & Kostikova, 2022). In this context, a comparative study of the effects of swimming and track running on the physical condition and working capacity of students acquires special practical and scientific significance, given the differences in the movement mechanics and loading characteristics of these activities [7, 11].

The aim of this study is to evaluate the impact of systematic swimming and running training on students' physical fitness, physical condition, health coefficient, and physical working capacity. Special attention was given to analyzing the dynamics of basic physical qualities, changes in the level of physical condition, and determining the degree of effectiveness of these types of physical activities within the framework of student health promotion programs.

The objectives of the study included:

1. To analyze the dynamics of physical fitness development among students in both experimental groups.
2. To identify changes in the level of physical condition and physical working capacity during systematic training sessions.
3. To evaluate the effectiveness of swimming and track running exercises in improving students' physical condition, health coefficient, and functional capacities.

To achieve the stated aims and to address the research objectives, an experimental program was developed, based on the application of a set of morphofunctional, testing, and statistical methods for the assessment of students' physical condition.

Organization of the Study

The study was conducted at the Department of Physical Culture and Sports of a pedagogical university in Uzbekistan. The research included students selected according to the following criteria: mean age — 20.16±1.4 years; eligibility for the main medical group based on health status; initial level of physical condition determined through morphofunctional assessments using express methods of physical condition evaluation (Thomas et al., 2020); expressed interest in the selected types of physical and sports activities — swimming and track running; and prior motor experience reflecting the level of mastery of basic motor skills and their practical application [7].

All students who expressed a desire to participate in the experiment confirmed their basic proficiency in the relevant types of physical activity and experience in systematic training in the chosen sports. Following preliminary assessment, 50 first-year male students who met the established requirements and completed the full experimental program (attending at least 80 % of all sessions and participating in all control tests) were selected.

Training sessions were conducted twice a week, each lasting 90 minutes. Based on the students' preferences and the results of initial physical fitness assessments, two experimental groups were formed: the "Running" group (25 students), who engaged in track running training, and the "Swimming" group (25 students), who trained according to a health-promoting swimming program.

The selection of means and methods of physical training was based on the students' age, gender, health status, physical development, functional capabilities, and baseline fitness level. The experimental work spanned the entire academic period during which students attended the "Physical Culture" course, with control measurements conducted at the beginning and end of the training cycle.

Training in the "Running" group was based on the principle of gradual increase in aerobic load. At the initial stage, students engaged in mixed locomotion involving walking and running at varying paces and durations. This approach allowed for progressive adaptation of the cardiovascular and respiratory systems to increasing physical demands. Subsequently, the proportion of walking was reduced, and the focus shifted to running, with an emphasis on increasing the speed of covering a 1 km distance. As a result, after a two-

month preparatory phase, 45–50 minutes of continuous running no longer caused signs of fatigue or health deterioration among the students [7, 9].

The organization of training in the "Swimming" group was based on a comprehensive approach incorporating health-oriented swimming exercises using the front crawl, backstroke, and breaststroke techniques. Each session was structured into introductory, main, and concluding parts. The introductory part included general developmental exercises aimed at improving flexibility, preparatory exercises for mastering swimming techniques, and light cyclic loads, such as walking and running on land. The main part focused on learning and reinforcing swimming techniques, with gradual increases in distance and active swimming time. As students' skills improved, sessions increasingly incorporated continuous swimming with short recovery periods in the water. The concluding part included strength exercises and special breathing exercises. All training sessions were standardized in terms of duration, intensity, and frequency according to the approved methodology [7, 9].

Methods and materials

A comprehensive methodology was applied in the study, incorporating morphofunctional tests, assessment of physical working capacity, physical fitness, and the general physical condition of the students. Physical working capacity was determined using the Harvard Step Test and the calculation of the Harvard Step Test Index (HSTI), allowing for the evaluation of the recovery rate of the cardiovascular system following a standardized physical load (Thomas et al., 2020).

The health coefficient was calculated based on morphofunctional data using heart rate, blood pressure, body mass, height, and age, according to the approved formula [11].

Physical fitness was assessed through control tests reflecting the development level of major physical qualities, such as strength, endurance, speed, and coordination [6]. Physical condition was evaluated based on morphofunctional indicators using modern express-assessment techniques [7].

Statistical analysis of the results included the calculation of the arithmetic mean, standard deviation, and application of the Student's t-test to determine the statistical significance of differences between groups (Borg, 2019).

A comparative analysis of the influence of swimming and running activities on students' physical fitness, general physical condition, and health coefficient enabled an objective evaluation of the dynamics of changes throughout the experiment.

Thus, the applied set of methods ensured a comprehensive evaluation of the investigated indicators and provided a solid foundation for interpreting the obtained results.

Results and Discussion

An analysis of the dynamics of heart rate (HR) during the preparatory phase of the training sessions allowed for the assessment of the adequacy of the "internal" load in both experimental groups. The HR indicators of students engaged in track running and swimming showed a consistent increase throughout the session, as presented in Table 1.

Table 1

Pulse Cost of Load During the Preparatory Phase of the Session in Experimental Groups at the First Stage of the Main Period

Group	Start of session	5th minute	10th minute	15th minute	20th minute
Running	69.2±4.5	86.1±5.8	96.5±8.1	106.7±6.7	117.2±5.8
Swimming	69.9±4.1	84.8±3.5	98.3±5.9	109.1±3.9	118.3±7.5

As can be seen from the data in Table 1, a gradual increase in HR was observed in both groups, reflecting a normal physiological response to the growing physical load. The differences between the groups, according to the t-test results, were not statistically significant ($p > 0.1$). At the same time, the load in the main part of the session caused an increase in heart rate up to 150–170 beats per minute, regardless of the type of exercise. Thus, despite differences in the structure of physical activity, cardiovascular responses in students of both groups were similar.

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At the beginning of the experiment, the physical condition of students in both groups was homogeneous for almost all measured indicators, except for the results of the "shuttle run" test. The level of development of students' physical qualities is presented in Tables 2 and 3.

Table 2

Indicators of Students' Physical Fitness at the Beginning and End of the Experiment

No.	Indicators	Running (Start)	Running (End)	Swimming (Start)	Swimming (End)
1	Speed (shuttle run 10×10 m, sec)	24.87±1.85	25.01±1.45	25.91±1.24	25.93±1.55
2	Handgrip strength (dynamometry, kg)	51.6±4.85	55.5±4.66	50.8±2.71	52.7±2.8
3	Muscular endurance (pull-ups, reps)	14±2.75	16±2.55	13.5±2.33	14.7±2.5
4	General endurance (1000 m run, min)	3.51±0.23	2.88±0.44	3.25±0.28	3.05±0.21
5	Adaptation level to physical load (Harvard step test, arbitrary units)	79.33±9.87	80.75±9.66	80.15±10.5	82.33±10.55

The results in Table 2 demonstrate a positive dynamic in the development of physical qualities in both groups. When comparing the 1000-meter running times, improvements were observed in both groups: 3.05±0.21 sec in the swimming group and 2.88±0.44 sec in the running group, with statistically significant differences between the groups. Statistically significant differences were also established in the "shuttle run" test results, where the students in the running group demonstrated higher speed levels (Table 3).

Table 3

t-Test Values Between the Experimental Groups "Running" and "Swimming" in the Study of Students' Physical Fitness Levels

No.	Indicators	Groups	Mean Values	t-test
1	Speed (shuttle run 10×10 m, sec)	Running / Swimming	24.87±1.85 / 25.91±1.24	1.37
		Running / Swimming	25.01±1.45 / 25.93±1.55	5.12*
2	Handgrip strength (dynamometry, kg)	Running / Swimming	51.6±4.85 / 50.8±2.71	0.26
		Running / Swimming	55.5±4.66 / 52.7±2.8	1.48
3	Muscular endurance (pull-ups, reps)	Running / Swimming	14±2.75 / 13.5±2.33	0.43
		Running / Swimming	16±2.55 / 14.7±2.5	2.41*
4	General endurance (1000 m run, min)	Running / Swimming	3.51±0.23 / 3.25±0.28	4.05*
		Running / Swimming	2.88±0.44 / 3.05±0.21	5.6*

*Note**. Statistically significant differences.

As shown in Table 3, most indicators of physical fitness demonstrated positive dynamics, particularly pronounced in the "Running" group. Changes in the physical condition of students in the experimental groups are indicated in Table 4.

Table 4

Students' Physical Condition Level at the Beginning and End of the Experiment (%)

Group	High (start)	Above average (start)	Average (start)	Below average (start)	Low (start)	High (end)	Above average (end)	Average (end)	Below average (end)	Low (end)
Swimming	6.4	32.9	44.9	11.2	3.6	9.3	38.9	34.8	12.2	2.7
Running	6.7	33.8	43.92	12.0	3.3	9.1	37.8	36.9	12.1	2.9

The data in Table 4 show that both groups experienced positive changes in students' physical condition levels. In the "Swimming" group, the increase in students with a high level of physical condition was 2.9 %, while in the "Running" group it was 2.4 %. As illustrated in Figure 1, the dynamics of changes in the level of physical condition were positive in both groups.

Thus, the conducted analysis allows us to conclude that both swimming and track running had a beneficial effect on the students' physical condition. However, the effectiveness of health-promoting swimming activities was somewhat higher, as evidenced by a greater increase in the proportion of students with a high level of physical condition and a decrease in the proportion of students with low indicators.

Physical working capacity is an important indicator of the body's functional state, reflecting a person's ability to perform specified physical work with minimal physiological costs while achieving maximum results. The assessment of students' physical working capacity was carried out using the Harvard Step Test (HSTI), which determines the recovery rate of the cardiovascular system after a standardized physical load. The dynamics of students' physical condition during the experiment are presented in Figure 1.

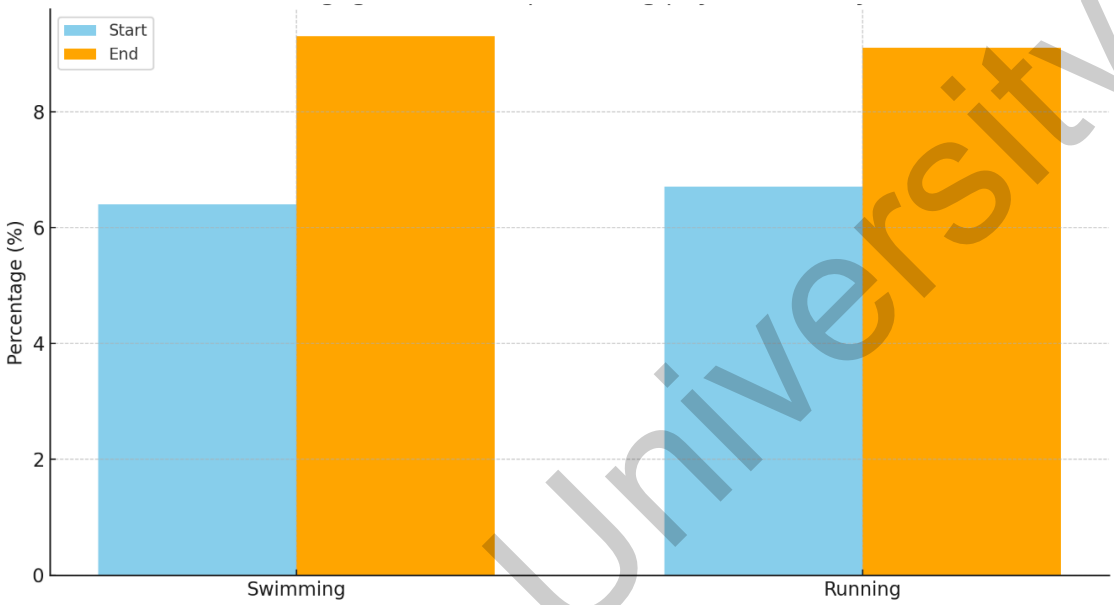

Figure 1. Physical condition level ("Above Average") of students engaged in health-promoting physical activity

Note. White cells indicate the beginning of the experiment; grey cells indicate the end; differences are not statistically significant.

The results of the Harvard Step Test Index (HSTI) calculations are demonstrated in Table 5.

Table 5

Level of Physical Performance of Students at the Beginning and End of the Experiment

Indicator	Group	Mean Value	t-test
Physical performance level (Harvard Step Test, arbitrary units)	Running	77.45±9.86 / 78.97±9.59	0.21 / 0.76
	Swimming	79.44±10.45 / 80.97±10.33	—

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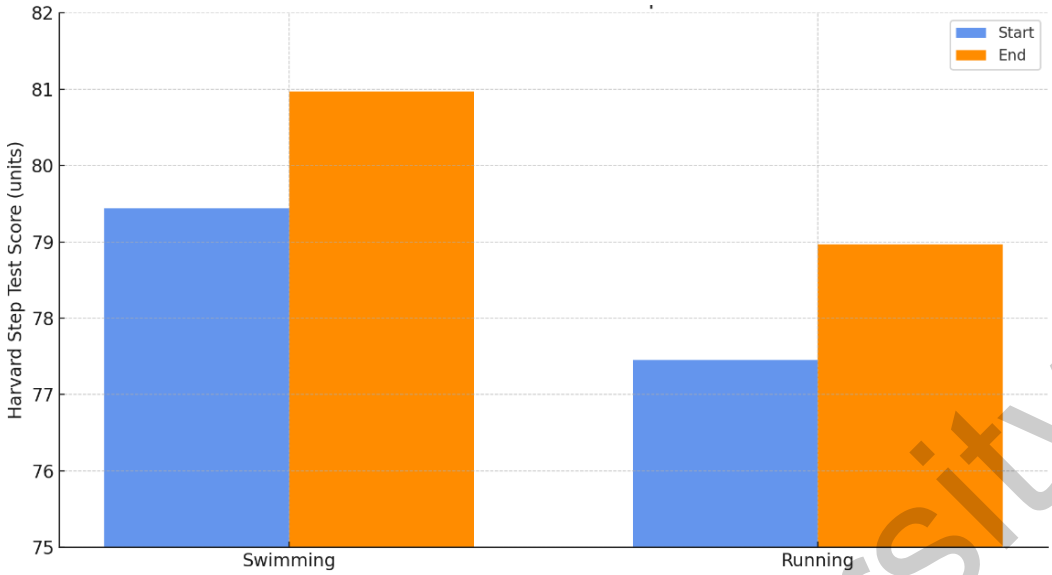

Figure 2. Students' Physical Performance Level

The analysis of the given data shows that the level of physical working capacity in the "Swimming" group was slightly higher compared to the "Running" group; however, no statistically significant differences between the groups were found. The visualization of the results is shown in Figure 2.

Additionally, an assessment of the students' health coefficient (HC) was conducted. Calculations were performed using the following formula:

HC = 0.01HR + 0.01SBP + 0.008DBP + 0.014A + 0.009BM − 0.009H − 0.27

where:

HR — heart rate,

SBP — systolic blood pressure,

DBP — diastolic blood pressure,

A — age,

BM — body mass,

H — height.

The mean health coefficient values were 2.115±0.19 in the "Swimming" group and 2.131±0.15 in the "Running" group. Differences between the groups were found to be statistically non-significant (Figure 3).

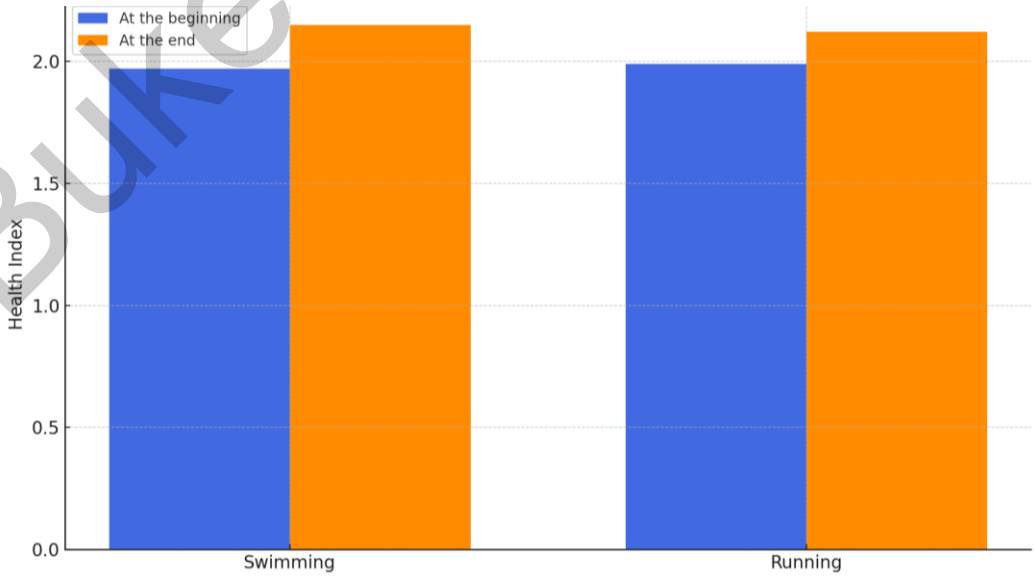

Figure 3. Health Index Indicators in the Experimental Groups

Summarizing the results, it can be noted that regular aerobic-oriented activities, regardless of the selected type of physical exercise, contribute to the improvement of students' physical working capacity and functional state. However, more pronounced positive trends were observed in the swimming group. These findings confirm the effectiveness of the systematic use of health-promoting swimming activities within the framework of university physical education programs.

Conclusions

The conducted study confirmed the high effectiveness of systematic aerobic-oriented physical training in improving the physical fitness, physical condition, and working capacity of students. The experimental results are consistent with current scientific findings emphasizing the important role of cyclic types of exercise, such as swimming and running, in developing the body's functional resilience [5–7].

The analysis of heart rate dynamics, physical fitness levels, physical condition, and health coefficient demonstrated positive changes in both experimental groups. Regular physical loads contributed to the activation of adaptive processes, which manifested in the improvement of key physiological indicators, a finding also confirmed by previous studies [3, 12].

The greatest effect was observed among students engaged in health-promoting swimming. This group showed a more pronounced positive dynamic in the development of physical qualities, improvement in physical working capacity, and enhancement of the health coefficient. These results align with the findings of Tanaka and Swensen (2022), who emphasized the significant health-promoting impact of regular swimming practice [13].

The comprehensive evaluation of the obtained data allows the conclusion that the inclusion of aerobic-oriented exercises, especially swimming, in university physical education programs is highly advisable:

1. The development of physical qualities showed positive dynamics in both experimental groups, with a greater increase in results by the end of the experiment observed among students in the "Swimming" group.

2. The dynamics of physical condition and working capacity were positive in both studied groups. However, the level of physical working capacity was slightly higher in the group engaged in health-promoting running, whereas the health coefficient and physical condition level were more pronounced in the "Swimming" group.

3. The most effective physical exercises contributing to the improvement of students' physical condition and working capacity were health-promoting swimming activities. The increase in the proportion of students with a high level of physical condition was 2.9 % in the "Swimming" group, compared to 2.4 % in the "Running" group.

The obtained results highlight the importance of aerobic exercises within the educational environment, particularly in shaping a healthy lifestyle and enhancing students' functional readiness. The integration of health-promoting swimming into university physical education programs appears to be a promising direction for strengthening students' health and fostering sustainable active lifestyle habits.

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