Comparative analysis of health indicators in relation to sports activities among student youth in Kazakhstan

Análisis comparativo de indicadores de salud relacionados con la actividad deportiva entre jóvenes estudiantes de Kazajistán

Authors

Bakhytzhan Zholdasbek [1]
Anastasiya Spaska [2, 3]
Andrei Aleshkin [4]
Vadim Anurov [5]

[1] Kazakh Academy of Sport and Tourism (Kazakhstan)
[2, 3] Ajman University (United Arab Emirates)
[4] Sechenov First Moscow State Medical University (Russian Federation)
[5] Financial University under the Government of the Russian Federation (Russian Federation)

Corresponding author:
Bakhytzhan Zholdasbek
bakhytzholdasbek@mailo.com

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Abstract

Introduction: the study aims to evaluate the effectiveness of a physical activity program in terms of its impact on the health of participants.
Objective: to achieve this goal, an integrated approach combining quantitative methods of assessment is employed.
Methodology A total of 150 participants were divided into three groups: Group 1 (n=37) followed a standard exercise program with general workouts twice weekly and lifestyle education; Group 2 (n=38) participated in an extended program with individual training sessions three times weekly, combining cardio, strength, and flexibility exercises, alongside personalized dietary and lifestyle advice; the control group (n=75) maintained their usual routines.
Results: The results indicated that Group 2 experienced the most significant improvements in health markers. The study's findings support the efficacy of tailored training programs that incorporate frequent and diverse physical activity.
Discussion: Participants in Group 2, who received the extended program, demonstrated more significant improvements than those in other groups, emphasizing the significance of a comprehensive approach to physical activity and healthy lifestyles.
Conclusions: It is advised to include such personalized interventions into public health initiatives to achieve better outcomes in disease prevention and treatment.

Keywords

Blood pressure; body fat percentage; body mass index; personal training; physical activity.

Resumen

Introducción: El estudio tiene como objetivo evaluar la efectividad de un programa de actividad física en términos de su impacto en la salud de los participantes.
Objetivo: Para lograr este objetivo, se emplea un enfoque integral que combina métodos de evaluación cuantitativos.
Metodología: Un total de 150 participantes se dividieron en tres grupos: El Grupo 1 (n=37) siguió un programa de ejercicio estándar con entrenamientos generales dos veces por semana y educación sobre estilo de vida; el Grupo 2 (n=38) participó en un programa extendido con sesiones de entrenamiento individual tres veces por semana, que combinaban ejercicios cardiovasculares, de fuerza y flexibilidad, junto con asesoramiento personalizado sobre dieta y estilo de vida; el grupo de control (n=75) mantuvo sus rutinas habituales.
Resultados: Los resultados indicaron que el Grupo 2 experimentó las mejoras más significativas en los indicadores de salud. Los hallazgos del estudio respaldan la eficacia de los programas de entrenamiento personalizados que incorporan actividad física frecuente y diversa.
Discusión: Los participantes del Grupo 2, que recibieron el programa extendido, demostraron mejoras más significativas que los de los otros grupos, lo que subraya la importancia de un enfoque integral de la actividad física y los estilos de vida saludables.
Conclusiones: Se recomienda incluir este tipo de intervenciones personalizadas en las iniciativas de salud pública para lograr mejores resultados en la prevención y el tratamiento de enfermedades.

Palabras clave

Presión arterial, porcentaje de grasa corporal, índice de masa corporal, entrenamiento personal, actividad física.

Introduction

The prevalence of non-communicable diseases has increased steadily over the past few decades and remains a significant global public health concern. Cardiovascular disorders, obesity and diabetes are now among the leading causes of morbidity and mortality in many countries (Agans et al., 2022). Insufficient physical activity and the growing prevalence of sedentary behaviour are major contributors to these conditions (Boccia et al., 2017; Brown et al., 2024; Pan et al., 2022). Urbanisation, prolonged screen time and reduced daily movement have significantly impacted lifestyle patterns, particularly among younger populations (Brown et al., 2024; Fortes et al., 2014).

University students are particularly vulnerable to low levels of physical activity. Academic workload, irregular schedules, stress and limited time for recreation can reduce participation in exercise and organised sports (Andersen & Schelin, 1994; Brown et al., 2024; Córdoba Camacho et al., 2026; Herbert, 2022; Hermida Bravo et al., 2026). Habits formed during this period often persist into later life, making it an important time for developing long-term health behaviours (Moseid et al., 2018).

These trends indicate the need for further research into effective strategies for promoting physical activity and improving health among university students (Herbert, 2022; Pan et al., 2022). A better understanding of the relationship between regular exercise and key health indicators in this population could inform the development of more effective preventative and educational programmes.

Previous studies have shown that regular exercise is associated with positive changes in body composition, cardiovascular function, metabolic regulation and psychological well-being. Physical activity improves cardiovascular performance by increasing circulatory efficiency and reducing the risk of hypertension and coronary disease (Glazkova et al., 2020). Regular training has also been linked to enhanced lipid metabolism and a reduced risk of atherosclerotic changes (Lin & Liu, 2023). Furthermore, exercise has a positive effect on respiratory function, improving oxygen utilisation and pulmonary capacity (Nurgul et al., 2018; Zhang & Yu, 2021). Endocrine responses to exercise, including the release of endorphins, have been linked to reduced stress levels and an improved emotional state (Ali, 2020; Herbert, 2022; Lin & Gao, 2023). Physical activity improves insulin sensitivity and plays an important role in preventing type 2 diabetes (Brand et al., 2022; Li et al., 2025a).

The effects of exercise depend on its type, intensity and duration. Certain high-intensity activities may be unsuitable for individuals with cardiovascular disorders or limited physical preparedness (Song et al., 2023). Certain categories of people, including those with musculoskeletal issues, may benefit more from low-impact activities such as swimming or cycling (Lin & Liu, 2023). Although strength-oriented exercise programmes can improve muscular fitness in young adults, improper training techniques may increase the risk of injury (Shozi et al., 2022). Recent randomized controlled trials among university students have demonstrated that structured functional training programmes can significantly improve physical fitness and movement quality (Li et al., 2025b). These findings suggest that physical activity programmes should take into account individual characteristics and training load.

The level of physical activity among young people varies considerably from country to country. In several European countries, including Germany and Sweden, around 40–50% of adults participate in regular sports (Pfisterer et al., 2022). Lower levels have been reported in the United States, Japan, China and Kazakhstan (Chen et al., 2020; Grasdalsmoen et al., 2020; Otaraly et al., 2020; Tsukahara et al., 2020). Many countries have introduced national initiatives aimed at increasing participation in physical activity, such as public health campaigns, educational programmes and the expansion of sports infrastructure (Chen et al., 2020; Grasdalsmoen et al., 2020; Otaraly et al., 2020; Pfisterer et al., 2022; Tsukahara et al., 2020). Despite these efforts, insufficient physical activity among university students remains common (Brown et al., 2024; Pan et al., 2022).

Participation in sports may also be associated with certain health risks. Intensive training can increase the likelihood of musculoskeletal injuries, particularly among young athletes who are exposed to high training loads and competitive stress (Botagariyev et al., 2021). The psychological pressure associated with sports performance may also contribute to anxiety and emotional exhaustion in some students (Bazarbaeva et al., 2021). At the same time, several studies have shown that appropriately designed physical activity programmes and mindfulness-based interventions may improve psychological well-being and reduce anxiety symptoms among university students (Komariah et al., 2022; Lin & Gao, 2023;

Riboldi et al., 2023). For this reason, the effectiveness of physical activity programmes should be evaluated in terms of not only athletic performance, but also broader health outcomes.

Although many studies have examined the relationship between physical activity and health, fewer have compared the different ways in which university students participate in sport. In Kazakhstan, despite growing interest in student health promotion and preventive medicine, this topic remains insufficiently studied. Further research is required to clarify the impact of structured training programmes on body composition and cardiovascular health in this population.

The present study examined the impact of regular sports participation and additional structured physical training on key health indicators among Kazakhstani university students. The analysis focused on changes in body mass index, body fat percentage, waist and hip circumference, blood pressure and heart rate after a 12-week intervention period.

Method

Sample

The study was conducted over a 12-week period from January to April 2024, at Al-Farabi Kazakh National University, Satbayev University, and Abai Kazakh National Pedagogical University, Kazakhstan. It involved 150 students, divided into two groups: an experimental group and a control group. The experimental group comprised students actively engaged in sports, and was further divided into two subgroups (Group 1 and Group 2). The control group, on the other hand, included students who did not participate in regular physical activity.

The experimental group consisted of 75 participants who regularly engaged in sports, including those participating in university sports teams and clubs. The control group comprised 75 individuals who did not regularly engage in physical activity (Table 1). Within each group, participants were grouped by gender and age to ensure equivalence and comparability. The experimental group was then divided into two subgroups, with 37 (Group 1) and 38 (Group 2) individuals. These subgroups were comparable in terms of gender and physical fitness levels. Group 1 consisted of 19 male and 18 female participants, while Group 2 had 19 male and 19 female participants. This distribution ensured gender balance and similarity in fitness levels in the subgroups.

Table 1. Demographic and Lifestyle Characteristics of Students

Indicator	Experimental group (n=75)	Control group (n=75)
Field of study		
Economics	20	22
Engineering	25	23
Humanities	15	14
Medicine	10	9
Law	5	7
Gender		
Male	38	36
Female	37	39
Age, years	20.3 ± 1.5	20.5 ± 1.4
Educational attainment		
Bachelor's degree	45	47
Master's degree	30	28
Marital status		
Not married	60	62
Married	15	13
Sports		
Activities	Football, volleyball, swimming, etc.	-
Frequency	2-3 times a week	-
Lifestyle habits		
Smoking	10	12
Alcohol	12	15

The general demographic and lifestyle characteristics of the students in both groups (Table 1) indicated similarity between groups in terms of field of study, gender, age, educational level, marital status, sports participation and lifestyle habits.

Research design

Students were selected through advertisements and invitations posted on the official websites of the institutions and on student groups' pages. In order to participate in the research, a preliminary screening process was conducted via a questionnaire to determine the physical activity level and health status of potential participants. The study used a comparative experimental design with pre- and post-intervention assessments. The aim of the study is to examine the impact of sports on students' health indicators.

Inclusion criteria:

Participants aged 18 to 25 years.

Willingness to voluntarily participate in the research.

Written informed consent to participate in the study.

For the experimental group: regular physical activity at least 3 times per week for the previous 6 months.

For the control group: lack of regular physical activity.

Exclusion criteria:

The presence of any chronic conditions that may interfere with the study's findings, such as cardiovascular disease, diabetes, musculoskeletal disorders, digestive disorders, or hormonal conditions.

Pregnancy or recent surgical procedures.

Failure to meet the requirements for participation or withdrawal from the study.

Ethical approval

Prior to the commencement of the study, all participants provided informed consent. The informed consent form detailed the objectives of the research, the procedures involved, potential risks, and the rights of the participants. Ethical approval was obtained from the relevant Ethics Committee of Al-Farabi Kazakh National University (Protocol no. 8782 dated from 12 December 2023), Satbayev University (Protocol no. 99098 dated from 16 December 2023), and Abai Kazakh National Pedagogical University (Protocol no. 497898 dated from 2 December 2023).

Experimental design

All participants underwent a preliminary medical assessment at medical facilities affiliated with universities (equipped with appropriate equipment). This assessment included measurements of physiological indicators (blood pressure, heart rate, stress levels, physical endurance), as well as a questionnaire regarding sociodemographic information and lifestyle habits. The questionnaire data were analysed quantitatively.

The experimental group participants were randomly assigned to either Group 1 or Group 2. The program consisted of a series of exercises designed to improve endurance, strength, and flexibility. The duration of the program was 12 weeks, with classes held 3-4 times per week for 3 hours. Sessions were conducted after regular academic classes. During the course of the study, intermediate assessments were conducted every two weeks to monitor changes in health parameters in both groups. At the end of the 12-week period, a final assessment of all participants took place, including a repeated measurement of physiological indicators and a survey. The study design allowed continuous monitoring of changes in health indicators throughout the intervention period.

Research methods

Group 1 continued to engage in their regular sports activities without any changes to the training program. This included regular training sessions, which the students had been practicing prior to starting

the study. These training sessions were held at university sports facilities, where students from all faculties were able to participate. The physical activity of Group 1 remained consistent over a 12-week period.

Group 2 participated in the sports that they were previously involved in, as well as followed a training program specifically designed as part of this study. This supplementary program incorporated aerobic exercise, strength training, flexibility exercises, and recovery sessions. Specifically, Group 2 engaged in cardio activities on aerobic equipment, such as running on a treadmill and using an exercise bike, three times per week for 30 minutes, with an intensity equivalent to 60%-70% of the maximum heart rate. Strength training focused on strengthening major muscle groups took place twice per week, while flexibility sessions (yoga or pilates) were conducted twice weekly. Recovery sessions, including breathing exercises and meditation, were scheduled once per week.

The methodology for the additional sports activities was devised by the researchers. Body mass index (BMI) was calculated by dividing the weight in kilograms by the squared height in meters (kg/m^2) at the beginning and end of the 12-week program. Body fat percentage was estimated using bioelectrical impedance analysis (BIA), which allowed for tracking changes in body composition. Waist and hip circumferences were measured with a measuring tape in order to assess changes in fat distribution. Blood pressure and heart rate were examined using automatic blood pressure and heart monitors before and after exercise sessions. Physical endurance was evaluated through treadmill tests, such as the Cooper Test, and flexibility was assessed through forward tilt and other stretching exercises.

Interim examinations were conducted every two weeks to monitor changes in health markers and, if required, adjust training regimens. At the conclusion of 12 weeks, a comprehensive assessment was conducted in order to evaluate the efficacy of the training program and compare results between the two groups. These procedures were used to gather comprehensive data on the effect of supplementary physical activity on student health.

Statistical analysis

To analyze the data collected during the study, SPSS Statistics software version 25.0 was utilized. The statistical analysis aimed to assess the differences between experimental groups and identify the impact of the additional training program on students' physical health. The Shapiro-Wilk test was used to verify the normality of data distribution. This test determined if the data conformed to a normal distribution, which is a prerequisite for selecting subsequent statistical methods.

For comparative analysis between the subgroups, the following techniques were employed:

Independent samples t-tests were used for normally distributed data and the Mann-Whitney U test was used for non-normally distributed data to assess changes in health indicators between groups before and after the intervention. The tests showed if there were statistically significant differences in the indicators (body mass index (BMI), fat percentage, waist and hip circumference, as well as blood pressure and heart rate values) between groups. Additionally, these tests made it possible to test the hypothesis regarding the effect of an additional training program on student health.

Covariance analysis (ANCOVA) was used to assess the effect of the additional training program on physical health, controlling for potential confounding variables such as age, gender, and baseline health indicators. ANCOVA accounts for the impact of these factors and isolates the net effect of the intervention on the target outcome. The Pearson correlation coefficient was used for normal distributions, and the Spearman correlation coefficients was used for non-normal distributions, to study the relationship between various health metrics and physical activity levels. This method allowed for determining the degree of association between changes in physical activity and changes in health metrics such as body mass index (BMI) and body fat percentage.

In order to conduct a more comprehensive analysis of the effect of the training program on health indicators, a multiple regression model was employed. This technique allows for the assessment of the impact of various exercises and their combinations on physical well-being, factoring in other variables such as baseline fitness levels and the presence of detrimental habits.

Statistical tests were selected according to data type and distribution characteristics. The analysis was conducted at a significance level of $p<0.05$, eliminating the possibility of random errors and confirming

the statistical significance of observed changes in the data. The G Power software version 3.1 was utilized to evaluate the study's statistical power. The statistical power of the study was computed considering the sample size of 150 individuals, an estimated significance level of 0.05, and an expected effect size of 0.8. The calculation revealed that the statistical power of the study was 0.80. This indicates that, with the given parameters of the research, there is an 80% likelihood of detecting a true effect if one exists. A value of 0.80 is deemed to be sufficiently high, confirming the capacity of the study in identifying significant differences and alterations in health markers between groups with a reasonable level of confidence. This level of statistical power indicates that the study was adequately powered to detect meaningful differences between groups and reduces the likelihood of type II errors.

Results

Table 2 presents the baseline health indicators for each group before the start of the study. In the control group, BMI was 0.1 kg/m^2 (0.5%) lower than in Group 1 and 0.2 kg/m^2 (0.9%) lower than Group 2. The Shapiro-Wilk test indicated that the distribution of BMI was normal ($p > 0.05$). Independent samples t-tests failed to reveal statistically significant differences between the groups ($p > 0.05$).

In the control group, body fat percentage before the start of the study was 0.1% higher than in Group 1 (0.5%) and 0.2% higher than in Group 2 (1.1%). The Shapiro-Wilk test confirmed that the distribution of data in both subgroups followed a normal pattern ($p > 0.05$). Independent samples t-tests also showed that there were no significant differences in body fat percentage between the two subgroups ($p > 0.05$).

The waist and hip circumferences were comparable between the study groups. In the control group, the mean waist circumference was 0.2 cm (0.3%) larger than in Group 1, and 0.3 cm (0.4%) larger than in Group 2, as shown in Table 2. Similarly, the mean hip circumference of the control group was found to be 0.1 cm (0.1%) larger than that of Group 1, and by 0.2 cm (0.2%) larger than that of Group 2. The Shapiro-Wilk normality test demonstrated that the data were normally distributed ($p > 0.05$), and the Independent samples t-tests revealed no statistically significant difference ($p > 0.05$) between the two groups.

In the control group, the blood pressure was 1 mmHg lower (0.8%) than in Group 1 and 1 mmHg higher (0.8%) compared to Group 2. The data were normally distributed (Shapiro–Wilk test, $p > 0.05$). There were no significant differences between the groups (Independent samples t-testss, $p > 0.05$).

In the control group, the heart rate was 1 bpm (1.4% higher) than in Group 1, and 2 bpm (2.8% higher) higher than in Group 2. The Shapiro-Wilk normality test confirmed that the distribution was normal ($p > 0.05$). Independent samples t-testss revealed no statistically significant differences ($p > 0.05$).

Table 2. Pre-Intervention Health Indicators

Indicator	Group 1 (n=37)	Group 2 (n=38)	Control group (n=75)
BMI (kg/m^2)	22.3 ± 2.1	22.4 ± 2.2	22.2 ± 2.0
Body fat percentage (%)	18.5 ± 3.4	18.4 ± 3.2	18.6 ± 3.5
Waist circumference (cm)	74.3 ± 5.1	74.2 ± 4.8	74.5 ± 5.0
Hip circumference (cm)	90.4 ± 6.2	90.5 ± 6.0	90.3 ± 6.3
Blood pressure (mmHg)	120/80 ± 10/8	121/81 ± 9/7	119/79 ± 11/9
Heart rate (bpm)	72 ± 8	71 ± 7	73 ± 9

Table 3 presents changes in health indicators following 12 weeks of the intervention. In Group 2, BMI was 0.5 kg/m^2 (2.2%) less than in the control group and 0.4 kg/m^2 (1.8% less) compared to Group 1. Independent samples t-testss revealed statistically significant differences between Group 2 and the control group ($p<0.05$), but not between Group 2 and Group 1 ($p>0.05$). In Group 2, the indicator of body fat percentage was 1.6% (8.7%) lower than in the control group and 1.4% (7.7%) lower compared to Group 1, as shown in Table 3. Independent samples t-testss demonstrated statistically significant differences between Group 2 and the control group ($p < 0.05$) as well as between Group 2 and Group 1 ($p < 0.05$).

In Group 2, the mean waist circumference was statistically significantly different from the control group by 1.9 cm (2.6%), and also different from Group 1 by 1.5 cm (2%). Independent samples t-tests results

showed that there were significant differences between Group 2 and the control group ($p < 0.05$). However, there were no significant differences between Group 2 and Group 1 ($p > 0.05$). In Group 2, the mean hip circumference was 1.7 cm (1.9%) lower than in the control group and 1.5 cm (1.7%) lower than in Group 1. The Independent samples t-testss revealed a significant difference between Group 2 and the control group ($p < 0.05$), but not between Group 2 and Group 1 ($p > 0.05$).

In Group 2, mean blood pressure was 5 mmHg (4.2%) lower than in the control group, and 4 mmHg (3.3%) lower than in Group 1, as shown in Table 3. Independent samples t-testss demonstrated statistically significant differences between Group 2 and the control group ($p<0.05$) as well as between Group 2 and Group 1 ($p < 0.05$). In Group 2, the mean heart rate was also 5 bpm (7.0%) lower compared to the control group and 4 bpm (5.6%) lower than in Group 1. However, Independent samples t-testss did not show significant differences between Group 2 and Group 1 ($p>0.05$).

Table 3. Post-Intervention Health Indicators

Indicator	Group 1 (n=37)	Group 2 (n=38)	Control group (n=75)
BMI (kg/m²)	22.2 ± 2.0	21.8 ± 1.9	22.3 ± 2.1
Body fat percentage (%)	18.2 ± 3.2	16.8 ± 3.1	18.4 ± 3.3
Waist circumference (cm)	74.0 ± 5.0	72.5 ± 4.5	74.4 ± 5.1
Hip circumference (cm)	90.0 ± 6.0	88.5 ± 5.5	90.2 ± 6.1
Blood pressure (mmHg)	119/79 ± 9/7	115/75 ± 8/6	120/80 ± 10/8
Heart rate (bpm)	71 ± 7	67 ± 6	72 ± 8

Table 4 presents the changes in health indicators for each group compared to the initial data. Group 2 experienced the greatest reduction in BMI, by 0.6 ± 0.4 kg/m², which is a 2.7% decrease, and this is 0.5 kg/m² (5.0%) greater than in Group 1 (-0.1 ± 0.3 кг/м²) and 0.5 kg/m² (5%) greater than the control group (+0.1 ± 0.2 кг/м²). The Mann-Whitney test revealed a statistically significant difference between Group 2 and Group 1 ($p < 0.05$), as well as between Group 2 and the control group ($p < 0.05$).

In terms of body fat percentage, Group 2 showed the largest decrease by 1.6 ± 0.7% (8.7%), which is 1.3% (6.9%) more compared to Group 1 (-0.3 ± 0.5%) and 1.6% (8.7%) more than in the control group (-0.2 ± 0.4%). The Mann-Whitney test showed significant differences between Group 2 and Group 1 ($p < 0.05$) and between Group 2 and the control group ($p < 0.05$).

Waist circumference in Group 2 demonstrated the most considerable decrease, by 1.7 ± 0.8 cm (2.3%). This is 1.4 cm (1.9%) greater than in Group 1 (-0.3 ± 0.6 cm) and 1.6 cm (2.1%) greater than the control group (-0.1 ± 0.5 cm). The Mann-Whitney test revealed statistically significant differences between Group 2 and both Group 1 ($p < 0.05$) and the control group ($p < 0.05$).

The mean hip circumference of Group 2 exhibited a pronounced decrease, by 2.0 ± 0.9 cm (2.2%) compared to the initial measurement. This indicator was 1.6 cm (2.3%) greater than that of Group 1 (-0.4 ± 0.7 см) and 1.9 cm (2.4%) greater than in the control group (-0.1 ± 0.6 см). According to the Mann-Whitney test, there were significant differences in the hip circumferences between Group 2 and both Group 1 ($p < 0.05$) and the control group ($p < 0.05$).

Regarding the indicators of blood pressure, Group 2 showed the largest decrease by 6/6 mmHg (5.0%), which is 7/6 mmHg (6.0%) more compared to Group 1 (-1/1 mmHg) and 7/7 mmHg (5.8%) more than in the control group (+1/1 mmHg). The Mann-Whitney test showed statistically significant differences between Group 2 and Group 1 ($p < 0.05$) and between Group 2 and the control group ($p < 0.05$).

The mean heart rate of Group 2 demonstrated a sharp decrease of 4 ± 3 bpm (5.6%). This was 3 bpm (3.6%) greater than in Group 1 and 3 bpm (4.2%) greater compared to the control group. The Mann-Whitney test revealed statistically significant differences between Group 2 and Group 1 ($p < 0.05$) as well as between Group 2 and the control group ($p < 0.05$).

Table 4. Comparative Analysis of Changes in Health Indicators

Indicator	Group 1 (Δ)	Group 2 (Δ)	Control group (Δ)	p-value (Group 1 vs Group 2)	p-value (Control group vs Group 2)
Changes in BMI (kg/m²)	-0.1 ± 0.3	-0.6 ± 0.4	+0.1 ± 0.2	0.01	0.02
Changes in body fat percentage (%)	-0.3 ± 0.5	-1.6 ± 0.7	-0.2 ± 0.4	0.03	0.01
Changes in waist circumference (cm)	-0.3 ± 0.6	-1.7 ± 0.8	-0.1 ± 0.5	0.04	0.05
Changes in hip circumference (cm)	-0.4 ± 0.7	-2.0 ± 0.9	-0.1 ± 0.6	0.02	0.03
Changes in blood pressure (mmhg)	-1/1 ± 4/4	-6/6 ± 4/4	+1/1 ± 3/3	0.04	0.03
Changes in heart rate (bpm)	-1 ± 3	-4 ± 3	-1 ± 2	0.05	0.04

An analysis of the trends in the main health indicators over the course of the study points to significant differences between the subgroups and the control group (Figure 1). Thus, the BMI of participants in Group 1 remained relatively constant throughout the monitoring period, fluctuating within a range of ±0.2 kg/m^2, as shown in Figure 1A. A slight decrease in BMI was observed towards the end of Week 12, although it was not statistically significant. In Group 2, a gradual decrease in BMI occurred, which became more pronounced towards the end of the study. Compared to Group 1 and the control group, this decrease indicates a significant positive impact of the intervention on BMI. The control group's BMI also remained relatively stable, with minor fluctuations and a small increase towards the end of the study (the increase was not statistically significant).

The percentage of body fat in Group 1 decreased gradually, although the reduction was less significant compared to Group 2 (Figure 1B). Group 2 showed a significant reduction in body fat percentage, particularly by the end of Week 12, confirming the high efficacy of the intervention. The control group exhibited a stable body fat percentage with minor fluctuations, with a slight increase towards the end of the study, which was not statistically significant.

The waist circumference data from Group 1 demonstrates a gradual reduction throughout the study period, suggesting the efficacy of the intervention (Figure 1C). Within Group 2, the waist circumference significantly decreased, with the most significant reduction occurring by the end of Week 12. This indicates a substantial positive impact of the intervention on this group. In contrast, the control group's mean waist circumference remained relatively stable, with minor fluctuations. A slight increase observed at the end of the study suggests that there was no significant impact of the intervention in this group.

The mean hip circumference in Group 1 slightly decreased throughout the study, with the most significant reduction occurring by the end of Week 12. However, this decrease was less pronounced compared to that observed in Group 2 (Figure 1D). In Group 2, the mean hip circumference decreased markedly throughout the study period, particularly by the end of Week 12, indicating a more significant effect of the intervention. The control group's indicators of hip circumference were stable with slight fluctuations, with a statistically insignificant increase towards the end of the study.

In general, Group 2 demonstrates the most positive changes in all major health indicators, indicating a profound impact of the intervention. Group 1 also displays improvements, albeit less pronounced than Group 2. The control group exhibits minimal changes.

Figure 1A. Dynamics of Changes in Key Health Indicators During the Monitoring Period (Every Two Weeks)

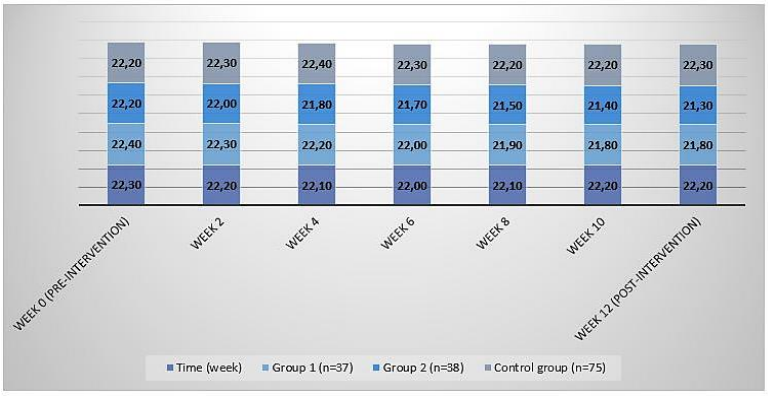

Figure 1B. Dynamics of Changes in Key Health Indicators During the Monitoring Period (Every Two Weeks)

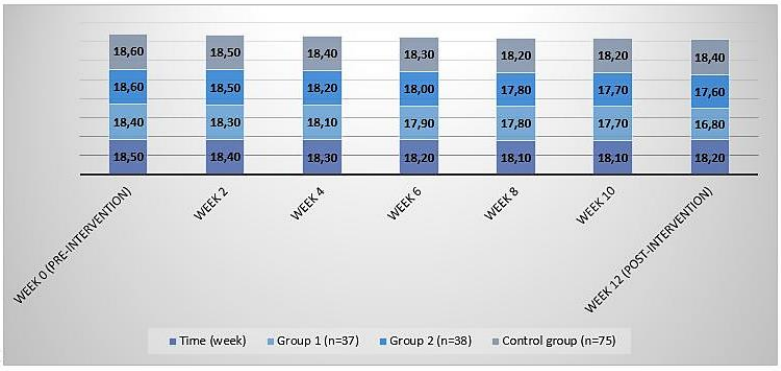

Figure 1C. Dynamics of Changes in Key Health Indicators During the Monitoring Period (Every Two Weeks)

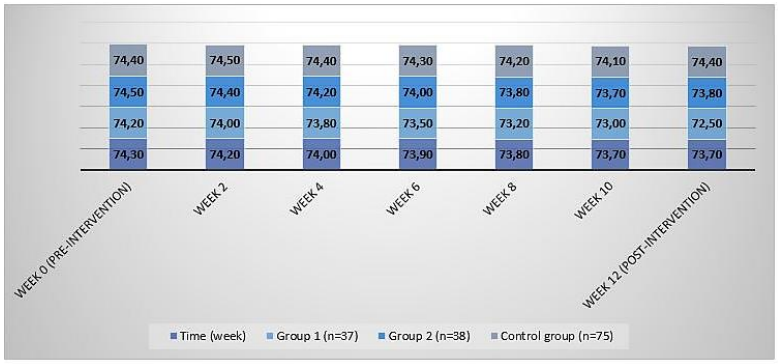

Figure 1D. Dynamics of Changes in Key Health Indicators During the Monitoring Period (Every Two Weeks)

Note: A - BMI (kg/m^2); B - body fat percentage (%); C - waist circumference (cm); D - hip circumference (cm)

Group 2 exhibited the most substantial improvements in all health metrics when compared to Group 1 and the control group. These findings suggest that the intervention used in Group 2 was more effective than the approaches used in the other groups. In order to draw more precise conclusions, we performed additional analysis utilizing more comprehensive data and considering additional factors such as adherence to recommendations or concurrent lifestyle modifications among participants.

The analysis of covariance (ANCOVA) took into account demographic and lifestyle-related variables, including gender, marital status, smoking, and alcohol consumption. The ANCOVA results revealed a strong impact of these factors on the study outcomes. Nevertheless, the effect of the intervention remains statistically significant. Specifically, despite differences in gender, marital status, smoking, and alcohol consumption, there was a statistically significant difference in the reduction of body mass index (BMI) between Group 2 and the control group. The reduction in BMI for Group 2 relative to the control group was 0.4 kg/m^2, which was statistically significant ($p < 0.05$). This finding confirms the effectiveness of the intervention program.

When analysing demographic and lifestyle-related variables, including gender, smoking, and alcohol consumption, the study found a 1.3% decrease in body fat percentage in Group 2 compared to Group 1 ($p < 0.05$). This reduction remained significant even after accounting for the influence of marital status and other variables. Additionally, there were statistically significant differences in the indicators of waist and hip circumference between Group 2 and the control group: mean waist circumference decreased by 1.3 cm ($p < 0.05$) and mean hip circumference decreased by 1.7 cm ($p < 0.05$).

An analysis of the relationships between health indicators and demographic and lifestyle-related variables using Pearson and Spearman correlation coefficients revealed that, in Group 2, female participants demonstrated a greater reduction in body fat percentage compared to male participants ($\rho = -0.56$, $p < 0.01$). Smoking was negatively correlated with levels of physical activity ($\rho = -0.62$, $p < 0.01$), confirming that quitting smoking contributes to improved intervention outcomes. Marital status also influenced the results, with unmarried participants showing a more significant reduction in BMI and body fat percentage than married participants ($\rho = -0.48$, $p < 0.05$).

Multiple regression analysis revealed that participants in Group 2 experienced a more pronounced reduction in body fat percentage ($\beta = -0.46$, $p < 0.01$) compared to the other groups. The discontinuation of lifestyle habits was associated with improved health outcomes, particularly a decrease in BMI ($\beta = -0.50$, $p < 0.01$). Additionally, unmarried participants demonstrated a more significant reduction in waist and hip circumferences ($\beta = -0.42$, $p < 0.05$) compared to those who were married.

These findings indicate that demographic and lifestyle-related variables influenced the outcomes of the intervention, yet the effectiveness of the program remains high regardless of the socioeconomic status of the participants. This confirms the success of the approach employed in Group 2 and its ability to improve the health outcomes of those involved. The results support the study hypothesis.

Discussion

The results showed that participants in Group 2 achieved greater improvements in most health indicators than participants in Group 1 and the control group. The most notable improvements were seen in the reduction of body mass index (BMI), body fat percentage, waist and hip circumference, as well as lower blood pressure and heart rate. These findings are corroborated by statistically significant differences when compared to Groups 1 and the control group, indicating that the intervention had a measurable positive effect on student health.

Group 2 showed the largest improvements, which may be related to the combination of structured training sessions and additional physical activity. This approach included personalized training and active participation of participants. The significant reduction in body fat percentage and improvements in other health markers may be due to the high level of physical activity and better adherence to the training programme. Similar findings were reported in recent randomized controlled trials and meta-analyses examining structured exercise interventions among university students (Li et al., 2025b; Ye et al., 2022). Our findings suggest that this approach requires further development, with a focus on personal-

ized training programs and the active engagement of participants. Moreover, it is also important to consider the influence of demographic and lifestyle-related factors, including gender, smoking, alcohol consumption and marital status.

Several limitations of this study should be considered when interpreting the findings. Firstly, the intervention only lasted 12 weeks, with no long-term follow-up. Consequently, it is unclear whether the observed improvements were sustained over time. Secondly, adherence to the training programme was monitored through attendance records only, so individual motivation and compliance outside of supervised sessions may have varied between participants. Thirdly, the study did not control for various external factors that could have affected the results, such as dietary habits, additional physical activity outside the programme, sleep patterns, and environmental conditions. These variables may have affected body composition and cardiovascular indicators independently of the intervention. Finally, the sample consisted only of university students from Kazakhstan, which limits the generalisability of the findings to other populations and age groups. These limitations should be considered in future investigations. In particular, improving the reliability and generalisability of findings may require longer follow-up periods, objective monitoring of adherence, and better control of dietary intake and additional physical activity. Similar methodological challenges have been discussed in recent systematic reviews focusing on physical activity behaviour among university students (Brown et al., 2024).

The present findings are consistent with previous studies examining the relationship between physical activity, body composition and cardiovascular health in young people. Several earlier investigations also reported reductions in BMI, body fat percentage and cardiovascular risk indicators following regular exercise interventions. Del Moral-Trinidad et al. (2021), which involved 3,869 university students from Mexico, analyzed anthropometric indicators and their association with self-regulation of diet and physical activity. The study primarily focused on BMI, as it was found to have the strongest correlation with body fat percentage. The results of the study confirmed the notion that BMI serves as the most reliable indicator of body fat among the studied parameters, aligning with our observations regarding the high informational value of BMI in assessing body composition.

Another study focused on comparing anthropometric data and bioelectrical impedance analysis among students (Anischenko et al., 2024). The results revealed a significant correlation between BMI and body fat percentage. This finding supports the use of anthropometric measurements when bioelectrical impedance analysis is not available.

Shalabi et al. (2023) assessed the impact of physical activity on BMI and other variables. The findings revealed a significant inverse relationship between the amount of physical activity and BMI. The authors reported an inverse relationship between physical activity level and BMI, supporting the role of regular exercise in weight control.

Other researchers examined the effects of high-intensity interval training (HIIT) on body composition and cardiovascular health in adolescents (Domaradzki et al., 2022). The study found that HIIT leads to substantial improvements in body composition and cardiovascular indicators (when compared to a control group). This finding validates the efficacy of intensive training for reducing fat percentage and enhancing overall physical fitness. Fagaras et al. (2024) has also uncovered a strong correlation between physical fitness and overall health. The results highlight the need for regular physical activity to maintain healthy levels of body fat and promote overall well-being.

Song et al. (2024) compared the impact of high-intensity and moderate exercise on body weight and biochemical parameters among obese students. The results showed that high-intensity exercise was more effective in reducing body fat percentage and improving biochemical markers, as compared to moderate exercise. These findings are comparable with the results observed in Group 2 in the present study. Some studies underscore the psychological implications of obesity in the student population, emphasizing the need for a holistic approach to weight control. Finally, the study conducted an aerobic exercise program among obese students and found that it was effective in promoting weight and fat loss, confirming the efficacy of such interventions (Suad et al., 2025; Zhou & Hazel, 2024).

The findings of the above studies broadly support our observations. Consistent with our data, previous investigations have identified BMI, body fat percentage, and physical activity as key factors in assessing health and body weight. Our study further supports the significance of personalized training regimens and regular exercise, lending credence to the conclusions of other studies. These discoveries are also in

line with studies that emphasize the significance of intense training and exercise for enhancing health, confirming their efficacy in managing body weight and enhancing fitness parameters.

Unlike previous studies, this research not only evaluated regular sports participation, but also the effect of an additional structured training programme combining aerobic exercise, strength training, flexibility sessions, and recovery activities. This approach enabled a more detailed evaluation of the changes to body composition and cardiovascular indicators that occurred during the intervention period. These findings could inform the development of student health promotion programmes and structured physical activity interventions in university settings.

Conclusions

The study showed that participants in Group 2 achieved better outcomes than participants in Group 1 and the control group. Analysis of key health indicators, such as BMI, body fat percentage, waist circumference, hip volume, blood pressure, and heart rate, has revealed statistically significant changes. In particular, Group 2 exhibited the greatest reduction in body fat percentage (-1.6%, p=0.01), waist circumference (-1.7 cm, p=0.05), and blood pressure (-6/6 mmhg, p=0.03). These findings are supported by the use of ANCOVA and multiple regression analysis. The results of these analyses indicate that the intervention's effect was significant and consistent, while controlling for sociodemographic variables. Group 2 exhibited more substantial improvements compared to both Group 1 and the control group, thereby highlighting the efficacy of the implemented intervention. The findings suggest that structured exercise programmes that combine several types of physical activity may improve student health indicators more effectively than regular sports participation alone.

The study's practical significance lies in the potential application of structured physical activity programmes in university settings to enhance body composition and cardiovascular health among students. The results may also inform the development of preventive health programmes aimed at reducing obesity- and cardiovascular-related risk factors in young adults. However, further studies with longer follow-up periods and more rigorous control of lifestyle-related variables are needed to better understand the long-term effects of such interventions.

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Authors and translators' details:

Bakhytzhan Zholdasbek	bakhytzholdasbek@mailo.com	Author
Anastasiya Spaska	anastasiyaspaska@outlook.com	Author
Andrei Aleshkin	vadimanurov@outlook.com	Author
Vadim Anurov	aaleshkin@alibagl.com	Author
Bakhytzhan Zholdasbek	bakhytzholdasbek@mailo.com	Translator