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Original Article

Variation in body composition under the impact of a short health-enhancing fitness training cycle in a university setting

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Abstract
Monitoring and evaluating the risks associated with deteriorating health, along with implementing preventive measures, are crucial steps in preventing socially significant diseases such as obesity, diabetes, cardiovascular disorders, osteoporosis, and allergic reactions. ***Purpose:*** This study compares the body composition of university students within the framework of an intra-university health project focused on weight reduction. ***Materials and methods:*** The study involved 65 first- and second-year students from a higher education institution. The experiment was performed as part of a health project by the Department of Physical Education aimed at preventing excess body weight (BM) among students. Participants underwent initial hardware testing using a specialized bioimpedance analyzer. Then, they were provided with specific physical exercises in a fitness format for a duration of two months. Control measurements were taken three times, with each measurement performed at the end of a two-week training cycle. The results from the bioimpedance testing were used to track the dynamics of changes. BM, body mass index (BMI), relative values of fat and muscle mass, and basal metabolism were measured. The results are presented as range charts with medians and the 25th–75th percentiles. ***Results:*** The study findings indicate changes in body composition indicators owing to the physical activity implemented in the experiment. Among the participants, a reduction in BM and stabilization of BMI at the normative value were observed. Furthermore, the relatively short training cycle influenced the muscle and fat mass indicators, as well as basal metabolism levels. ***Conclusions:*** Further research in this area should focus on a differentiated approach to selecting time intervals and the intensity of physical activity. This will help refine a personalized approach to implementing educational and practical physical education sessions, considering individual levels of motor activity.
Keywords: Physical Education, Bioimpedancemetry, Physical Exercise, Health Project

Introduction

Dynamic health monitoring, combined with preventive measures, plays a crucial role in mitigating negative conditions in young individuals (Zhou et al., 2025). It is well-established that one of the key factors negatively impacting modern health is physical inactivity (Baltazar-Meza & Custodio, 2025; Zawada et al., 2025). In combination with poor dietary habits and irregular sleep–wake patterns, physical inactivity is a primary contributor to pathological weight gain (Lankila et al., 2025; Jowshan et al., 2025). This, in turn, leads to imbalances and a decline in overall health (Tomás Reyes-Amigo, 2021; Hermassi et al., 2024).

These changes considerably impact students enrolled in higher education programs, who face a variety of unfavorable factors. Successfully addressing these issues depends largely on their individual adaptation reserves (Zaffina et al., 2022). When designing personalized strategies to eliminate harmful factors that affect the health of student youth, it is essential to consider the scientific and practical base that integrates information on preventing excess weight and related maladaptation conditions (Campa et al., 2021). Furthermore, a lack of attention to body weight (BM) disorders may negatively impact the student's future professional career (Evsenyeva et al., 2022; Kolokoltsev et al., 2023).

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In our view, the relevance of this work stems from the need to develop scientifically grounded approaches to analyzing body composition for creating personalized physical activity programs that consider the functional characteristics of students' bodies. While BM is a key indicator of physical health, there is a lack of sufficient research focused on deviations in BM and other anthropometric parameters from age-related norms adjusted for height and weight. Failure to recognize current BM issues can negatively impact students' future professional and work activities, potentially leading to long-term consequences that affect the development of essential professional qualities and the maintenance of a high level of health in future specialists (Vorozheikin, 2020; Taniguchi et al., 2021; Xu et al., 2022).

Research on the body's adaptive capabilities, with a focus on segmental body composition among university students, has progressed through the work of Mikhailova et al. (2018). This study focuses on identifying and preventing physical developmental characteristics and disorders that emerge during ontogenesis. It also presents methods for managing health by preventing excess BM. Additionally, bioimpedance analyzers, widely used in scientific research and practical applications, offer high accuracy and valuable insights for determining body composition components (Muchiri et al., 2022; Palamarchuk et al., 2024).

Modern trends in managing health-preserving components in higher education require the development and optimization of new approaches to studying pathological conditions that arise owing to excess BM and other negative factors (Romanova et al., 2024; Guryanov et al., 2024). However, despite existing scientific literature on this topic, this area of research remains underexplored. It is well known that university education entails significant cognitive and physical stress, imposing substantial demands on the body's adaptive resources (Grajek, & Sobczyk, 2021; Herbert, 2022; Genc, &Pirincci, 2024). When regulatory systems are not functioning in harmony, it can lead to a breakdown of adaptation processes, which, if unaddressed, results in a decline in health, physical activity, and the quality of daily life (Lojdová et al., 2021). Given this, maintaining the optimal state of the body relies on periodic bioimpedance testing to obtain accurate data on body composition. This approach supports the development of tailored, high-level programs that take individual characteristics into account, ultimately improving the body's functional state and overall health.

The objective of this study is to comparatively assess the body composition of university students within the framework of an intra-university health project aimed at reducing BM.

Materials and methods

The experiment involved 65 male students (18.3 ± 0.8 years old) from the first and second years of study at the Volga Region Research Medical University in Nizhny Novgorod, Russia. All participants had no contraindications to physical exercise as outlined in the physical education curriculum. The study was part of a periodic monitoring initiative of body composition parameters performed within an intra-university health project by the Department of Physical Education and Sports. This project aimed to monitor and reduce excess BM and obesity among university students. All participants provided informed, voluntary consent to participate in the experiment in full accordance with the guidelines of the 2008 Helsinki Declaration regarding human participation in research. Scientists from various universities in Russia, Kazakhstan, and Kyrgyzstan participated in the study.

As a baseline, we performed an initial test and analyzed the indicators using the bioimpedance method. Then, the students participated in physical exercise sessions lasting 90 min twice a week. The sessions were focused on fitness, specifically CrossFit, where students performed exercises using the high-intensity circuit training method. The physical exercises included squats, arm bends and extensions in a prone position, and lifting and lowering the body from a prone position. The equipment used consisted of dumbbells, rubber resistance bands, medicine balls, a jump rope, and a coordination ladder for jumping and running exercises. Strength training was performed on a high bar and a Swedish wall, along with partner exercises for the students.

Body mass and composition parameters were monitored over a two-month period. Every two weeks, control studies were performed to record and evaluate the dynamics of changes in the bioimpedance results for the students. Body composition and its morphofunctional parameters were analyzed using the "Sports Testing System MedicalSoft" software and hardware complex (MS FIT - 01, Russia). The following parameters were used as control markers: BM in kg, body mass index (BMI) in kg/m^2, muscle mass (MM) in %, fat mass (FM) in %, and basal metabolism in kcal.

For statistical analysis of the data, the computer programs Statistica 10.0 and Excel 2016 (Windows operating system) were used. The Shapiro–Wilk test was applied to assess the normality of the data distribution. The results of the data analysis are presented in box plots, showing the median (Me) as well as the 25th and 75th percentiles. The reliability of the differences was assessed using an analysis of variance for repeated measurements. Results were considered statistically significant at $p < 0.05$.

Results

At the first stage of the health project aimed at BM correction in students, this indicator was examined, with its quantitative representation presented in Table 1.

Table 1. Changes in body weight in students during the health project

Indicators	Before classes	First control	Second control	Third control
Mean value, kg	63.5	62.4*	61.9	61.1*^{x}
Median, kg	58.3	57.9	57.1*$^{\#}$	56.7*^{x}
Minimum value, kg	47.2	46.9	46.1*$^{\#}$	46.2*
Maximum value, kg	82.3	80.7*	78.5*$^{\#}$	75.1*^{x}

*Note: * – the statistical significance of differences compared to the category "Before classes," p < 0.05; # – the statistical significance of differences compared to the category "First control," p < 0.05; x – the statistical significance of differences compared to the category "Second control," p < 0.05*

The average BM before the start of physical exercise was recorded as 63.5 kg among the participants (median 58.3; min 47.2; max 82.3). During the course of the physical exercise program, a gradual decrease in BM was observed in the control measurements. By the end of the first cycle of classes, the average BM had decreased by 1.8% (Me 57.9; min 46.9; max 80.7). Notably, the third control measurement showed a reduction in BM of 3.9% from the initial level (Me 56.7; min 46.2; max 75.1), with statistical significance at $p < 0.05$. It is noteworthy that a decrease in BM was observed in nearly all the measurements. Additionally, the impact of physical exercise as a means of increasing MM should be considered because this contributes to an increase in the minimum BM. However, positive effects from physical exercise may not have been observed in some participants, likely owing to inadequate dietary practices. These students showed little to no change in this parameter. During the analysis of BMI changes, a decrease in this indicator was observed, reflected in statistically significant differences, as shown in Figure 1.

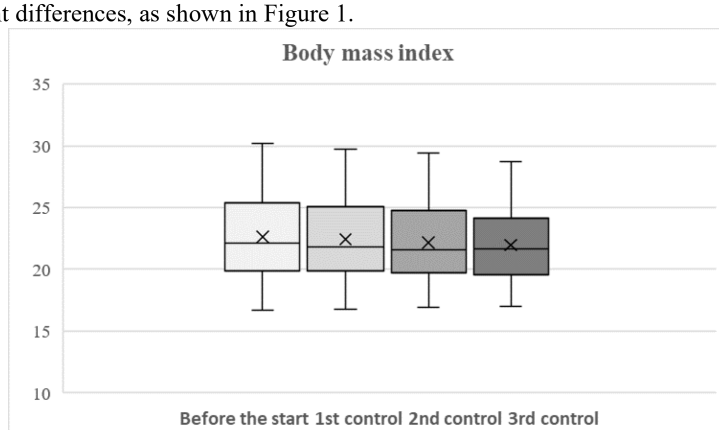

Fig. 1. Diagram of the body mass index range in students at the beginning of the health project and after each control measurement, kg/m^2

Compared to the control, the value of this indicator decreased by 0.8% (Me 21.7; min 16.3; max 28.9) after the first control measurement. By the end of the second control measurement, a further decrease of 2.2% (Me 21.8; min 16.5; max 28.4) was observed, and after the third, a reduction of 3.1% (Me 21.7; min 16.5; max 27.3), $p < 0.05$. These changes align closely with the observed shifts in body mass. However, some students experienced an increase in BMI, which could be attributed to an increase in skeletal MM.

Analysis of the study results revealed changes in the ratio of fat to MM in the students' bodies as a result of the training program implemented in the health project, as shown in Figures 2 and 3.

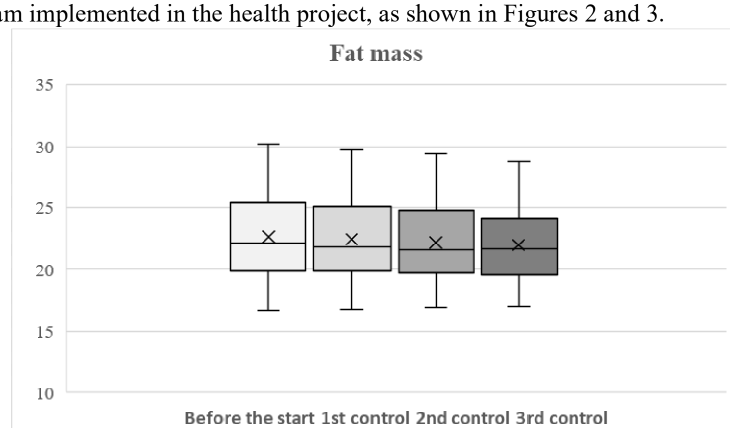

Fig. 2. Diagram of the range of relative body fat values in students at the beginning of the health project and after each control measurement, %

The first control testing recorded a 1.1% decrease in the average FM indicator (Me 24.6; min 5.1; max 33.2). By the second stage of the study, this parameter had decreased by 2.9% (Me 24.1; min 5.2; max 32.7), and by the third control testing, the decrease was 4.5% (Me 23.6; min 5.2; max 32.3) compared to the initial values recorded before the start of the training, $p < 0.05$. The dynamics of the visceral fat indicator are of particular scientific interest, with its quantitative visualization provided by the hardware and software complex used in the study. An in-depth analysis of this parameter is planned for future stages of the research.

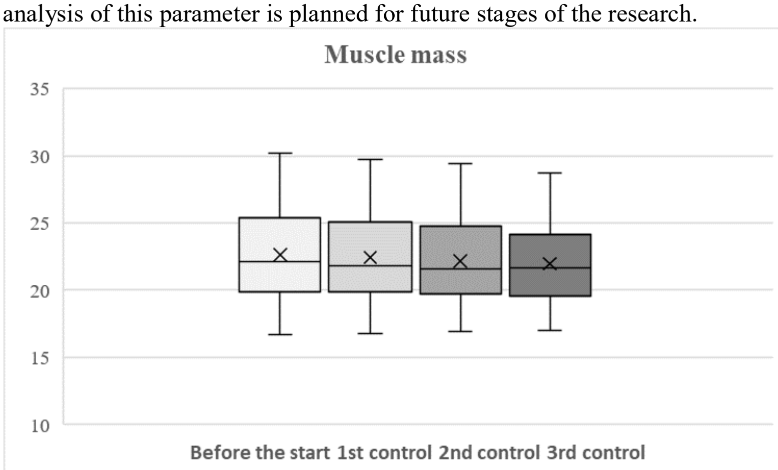

Fig. 3. Diagram of the range of relative muscle mass values in students before the start of physical exercise and after each control measurement, %

Regarding MM, its average level showed statistically significant growth. After the first control measurement, this indicator increased by 0.9% (Me 40.3; min 34.2; max 50.3). After the second control, the increase was 1.6% (Me 40.6; min 34.5; max 50.6), and by the third stage of the study, it had increased by 2.3% (Me 40.9; min 34.8; max 50.9), $p < 0.05$. One participant, who initially had a low level of FM and high MM, also participated in the experiment. At the beginning of the project, this participant already had a developed level of physical fitness and regularly engaged in physical exercises, expressing a strong interest in joining the research. Additionally, an assessment of the basal metabolic rate was performed, serving as a key indicator of the intensity of metabolic processes in the students' bodies.

This parameter reflects the energy needs of vital organs under conditions of complete physical and psycho-emotional rest. It is important to note that as the level of physical activity increases, metabolic processes accelerate, which in turn influences the basal metabolic rate.

The study found that changes in the intensity of physical activity could lead to variations in the body's energy sources, with carbohydrates and lipids being the primary substrates for oxidation. In extreme conditions, protein structures may also be used. The degree of physical activity is not the only significant factor in this process; the body's overall adaptation to varying conditions of motor activity also plays a crucial role. An increase in basal metabolic rate can result not only from an increase in MM owing to consistent physical training but also from enhanced functional activity of organs and tissues involved in regulating energy balance and the body's adaptive mechanisms. The state of basal metabolism in students during the implementation of the health project is presented in Figure 4.

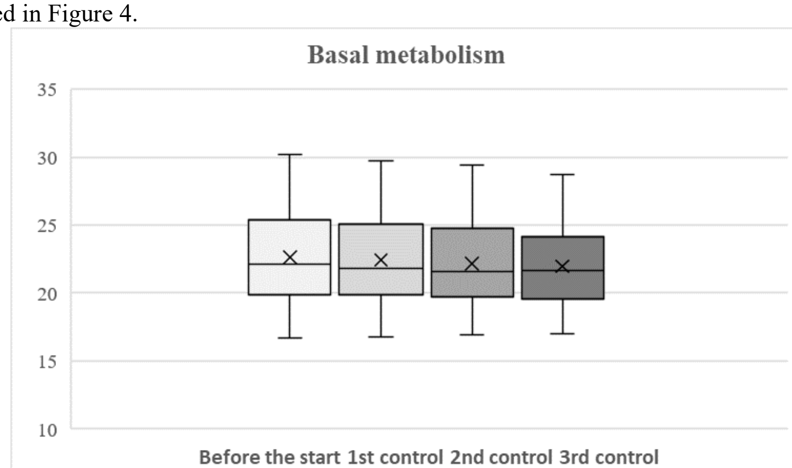

Fig. 4. Diagram of the range of basal metabolism values in students during the health project

Before the start of the project, the average value of this indicator was 1450.1 kcal (Me 1435.0; min 1310.0; max 1910.0). The subsequent dynamics show an increase in metabolic activity: after the first control measurement, metabolism increased by 0.4% (Me 1439.0; min 1315.0; max 1915.0). After the second control, a further increase of 0.9% in basal metabolism was observed (Me 1445.0; min 1317.0; max 1920.0), and by the third measurement, the increase was 1.1% (Me 1440.0; min 1312.0; max 1912.0). The group included a student with a high MM content. This is accompanied by an increase in basal metabolism, presumably owing to a high level of daily physical activity.

Discussion

Metabolic processes in the human body are subject to changes that are caused by environmental factors and lifestyle factors. This confirms the need to obtain scientific data on the component composition of the human body (Taniguchi et al., 2021; Xu et al., 2022). At the same time, the state of energy-metabolic and metabolic processes can be monitored using instrumental studies, in particular, visualization of body component composition indicators (Safiri et al., 2022; Romanova et al., 2024). It is known that the previously mentioned indicators are based on monitoring the active and reactive resistance of the body. This, in turn, is implemented using bioimpedancemetry procedures using analyzers (Priidel et al., 2020). Upon receipt of these values, individual body composition indicators are calculated, which include components of fat and muscle mass. Determination of the level of visceral adipose tissue, the ratio of intra- and extracellular water, active cell mass, metabolism, etc. play a significant role. The safety of using bioimpedance analysis, which uses a probing current of no more than 2 mA, has also been proven, and the only contraindication to the study is the presence of a pacemaker in the subject (Bocharin et al., 2023; Guryanov et al., 2024).

In the presented work, using the hardware method, a characteristic of the component composition of the body was obtained. The obtained parameters of bioimpedance analysis were analyzed taking into account the dynamics of their shifts under the influence of the proposed set of health-impeding physical exercises over two months of training. A statistically significant decrease in body weight was found in most subjects, and the body mass index also shows the dynamics of achieving results close to the optimal value of the indicator. Our data are consistent with the results of a study by other authors (Muchiri et al., 2022; Palamarchuk et al. 2024), who studied the dynamics of the component composition of the body of young people. According to the data of the indicated authors and the results of our research, quantitative changes in the content of fat and muscle mass in relative units, as well as an increase in metabolism taking into account the parameter of the basal metabolism of the students' body, are noted.

The use of a hardware and software system integrated with a bioimpedance analyzer allows for a comprehensive analysis of the body's component composition and timely tracking of changes recorded through testing. In turn, this allows for the necessary individual correction and dosage of physical activity, which improves the quality of educational and practical classes in physical education and sports.

Conclusions

The study results indicate changes in the body composition indicators of students as a result of the physical activity implemented in the health project aimed at correcting BM. The participants showed a reduction in BM and stabilization of BMI within the normative range. Additionally, the relatively short duration of the training sessions influenced muscle and FM indicators, as well as basal metabolism levels.

Further research in this area should involve a differentiated approach to selecting time intervals and intensity of physical activity. This will help optimize a personalized approach to implementing educational and practical physical education programs for young people, considering their individual levels of motor activity.

Conflicts of interest. The authors declare no conflict of interest.

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