

Identifying differences between body parameters in young people according to gender and age

Florin Marin Litoi

Department of Physical Education and Sports, University of Bucharest, Romania

Abstract

Background. Body structure parameters are essential health status indicators about gender, age, lifestyle, physical activity level, and other factors.

Aims. The study aimed to identify gender-based differences in body composition among active students aged 19 to 23.

Methods. This longitudinal study included 283 students, 144 males (50.8%) and 139 females (49.2%). The primary body parameters assessed were height (cm), weight (kg), body mass index (BMI), fat mass (kg), muscle mass (kg), bone mass (kg), and hydric mass (kg). The Tanita Health Monitor was used for body composition analysis, and an electronic stadiometer was utilized for height measurement.

Results. ANOVA analysis highlights statistically significant differences among the five male age groups only for BMI ($p = 0.042$) and muscle mass ($p = 0.048$). Among the five female age groups, significant differences were observed only for fat mass ($p = 0.046$). No statistically significant differences were found in the other body composition parameters among the five age groups about gender.

Conclusion. The differences recorded among age groups show a positive dynamic for all body composition parameters in both genders, with average values falling within normal reference limits in relation to gender and age. These findings underscore the importance of understanding body composition differences among students and can guide the development of future health strategies.

Keywords: height, weight, BMI, fat mass, muscle mass, bone mass, hydric mass.

Introduction

At the current stage of human evolution, an increasing number of experts consider body composition to be a relevant parameter for assessing health. Students, through their academic activities, face numerous intellectual, physical, health, and social challenges. Monitoring health is essential for preventing obesity and overweight, reducing the risk of metabolic, cardiovascular, and musculoskeletal diseases, and maintaining optimal physical and mental fitness. Imbalances in body composition, including weight, hydric mass, fat mass, or bone mass, are often associated with the onset of various pathologies and lower academic performance (López-Sánchez et al., 2019; Badau et al., 2018; Maïmoun et al., 2016). This study aims to identify gender-based differences in body composition among active students aged 19 to 23.

Understanding how body composition parameters evolve about age and gender is expected to contribute to expanding knowledge in morphological analysis and identifying aspects that require increased attention regarding health and the development of proactive behaviors among students (Alpaslan et al., 2017; Beaudry

et al., 2019; Jaremków et al., 2024). Risk factors for body composition imbalances include lifestyle, genetic predispositions, and environmental and educational factors. Implementing a healthy lifestyle - where physical activity, balanced nutrition, and stress management are essential - should prioritize optimizing body composition among young populations (Badau et al., 2021; Bahat et al., 2019; Deliens et al., 2019).

The academic environment imposes complex activities and requires students to adapt to multiple challenges, including academic schedules, time management, stress, and the management of physical and mental resources (Ben Mansour et al., 2021; Redondo-Flórez et al., 2022; Versic et al., 2021). This study aims to highlight morphological differences between genders based on age. The age range of 19-23 years was selected because most of the student population falls within this interval. Additionally, identifying differences in students' body composition will facilitate the development of the most appropriate solutions for optimization through physical activities, individual resource management, stress reduction, and health prevention strategies.

Received: 2025, February 4; Accepted for publication: 2025, February 15

Address for correspondence: University of Bucharest, 4-12 Regina Maria Av., PC 030018 Bucharest, Romania

E-mail: litoiflorin@gmail.com

Corresponding author: Florin Marin Litoi; litoiflorin@gmail.com

<https://doi.org/10.26659/pm3.2025.26.1.16>

With a clear focus on gender-based differences in body composition among active students aged 19-23, the study aimed to provide comprehensive insights into this important health aspect.

Hypothesis

The study's hypothesis was based on the assumption that there are significant gender differences in relation to age among students aged 19-23 years, specifically concerning body composition parameters. We expected to find distinct patterns in body composition among different age groups and genders.

Material and methods

a) Period and place of the study

The study was conducted over two months, from October to November 2024, with all participants voluntarily enrolling. Body composition parameters were assessed during university physical education classes for students (not specializing in sports) at the University of Bucharest under standardized conditions. Tanita - Health Monitor Version 3.2.4 was utilized for body mass and composition analysis, while an electronic stadiometer was used for height measurement. The measurement protocols adhered to standardized procedures to ensure accuracy and reliability, with all assessments conducted simultaneously to minimize potential variations.

b) Subjects and groups

The study included 283 students, 144 males (50.8%) and 139 females (49.2%). The distribution of students by age and gender was as follows: 19 years – 34 males, 32 females; 20 years – 36 males, 28 females; 21 years – 34 males, 34 females; 22 years – 18 males, 21 females; and 23 years – 22 males, 24 females. Inclusion criteria for the study encompassed age between 19 and 23 years, active student status, participation in university physical education classes, good health status, and completion of all required measurements specified in the study protocol.

c) Body composition evaluation

The primary body composition parameters assessed in this study included height (cm), weight (kg), body mass index (BMI), fat mass (kg), muscle mass (kg), bone mass (kg), and hydric mass (kg). Body mass index (BMI) was calculated using the standard formula:

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 (\text{m})$$

All measurements were conducted under standardized conditions to ensure accuracy and reliability, following established protocols for anthropometric assessment.

This study evaluated body composition parameters, each crucial in understanding overall body composition and health status:

- Weight refers to total body mass, which includes fat mass, muscle mass, bone mass, water mass, and organ weight.

- Body Mass Index (BMI) is a widely used parameter for assessing body weight and height, indirectly measuring body fatness.

- Fat Mass (kg) represents the total amount of adipose tissue in the body, including both essential fat (necessary for physiological functions) and storage fat (accumulated for energy reserves).

- Muscle Mass (kg) refers to the total weight of skeletal muscles, which are essential for movement, posture, and metabolic regulation. Higher muscle mass is generally associated with increased strength, improved metabolic rate, and better physical performance.

- Bone Mass (kg) indicates the total mineral content of bones, reflecting skeletal health; bone mass is influenced by genetics, physical activity, and nutritional intake, particularly calcium and vitamin D levels.

- Hydric Mass (kg) represents the total body water content essential for maintaining cellular function, thermoregulation, and overall homeostasis; water proportion in body composition can be influenced by hydration status, physical activity, and metabolic processes.

These parameters were assessed using a Tanita, which employs bioelectrical impedance analysis (BIA) to estimate body composition based on electrical conductivity differences between tissues.

d) Statistical processing

Statistical analysis was conducted using SPSS version 29, incorporating the evaluation of key statistical parameters, including the arithmetic mean, standard deviation (SD), variance, and the 95% confidence interval (CI) with upper and lower limits. The applied statistical tests comprised Student's t-test (t) and analysis of variance (ANOVA), with a significance threshold set at $p < 0.05$. Skewness and Kurtosis values were examined to assess the normality of data distribution, where Skewness within the range of -2 to +2 and Kurtosis between -7 and +7 indicated acceptable data symmetry. The Shapiro-Wilk test was also performed, and a p-value greater than 0.05 confirmed the normality assumptions. Given these results, applying the Student's t-test was deemed appropriate for the study.

Results

Table I shows that the Skewness and Kurtosis values fall within the reference limits, indicating a normal symmetrical distribution of results across all body composition parameters. For the male groups, the highest recorded values for each parameter are as follows: Height: 179.52 cm at the age of 23; Weight: 74.238 kg at the age of 19; BMI: 23.632 at the age of 19; Fat mass: 11.470 kg at the age of 19; Muscle mass: 59.658 kg at the age of 19; Bone mass: 3.138 kg at the age of 23; Hydric mass: 31.594 kg at the age of 22. The arithmetic mean of the body composition parameters for the male groups falls within the normal values relative to age.

Analyzing the results for the female groups presented in Table II, it can be observed that the average values recorded for all ages fall within the normal reference values for morphological development. Examining the results, we find that the highest recorded values for each parameter are as follows: Height: 164.916 cm at the age of 23; Weight: 61.050 kg at the age of 23; BMI: 22.250 at the age of 23; Fat mass: 16.175 kg at the age of 23; Muscle mass: 44.942 kg at the age of 22; Bone mass: 2.283 kg at the age of 23; Hydric mass: 31.594 kg at the age of 22. The Skewness and Kurtosis values fall within the reference limits, indicating a normal symmetrical distribution of results across all body composition parameters.

Table I
Descriptive statistics of body composition parameters of male groups.

Parameters	Age	Mean	SD	Variance	Skewness	Kurtosis
Height	19	176.882	5.798	33.622	.288	1.021
	20	178.161	9.452	89.343	-1.022	.659
	21	177.581	7.549	56.993	.469	-1.055
	22	177.333	8.106	65.714	.505	-1.082
	23	179.52	8.517	72.542	.056	-1.298
Weight	19	74.238	12.793	163.685	.603	.378
	20	70.033	13.158	173.141	-.019	1.034
	21	73.866	10.556	111.429	.082	1.238
	22	73.447	9.943	98.879	.024	.705
	23	73.500	12.944	167.570	-.108	-.709
BMI	19	23.632	3.260	10.631	.940	1.031
	20	21.897	2.859	8.179	.897	1.039
	21	23.397	3.013	9.083	.577	2.408
	22	23.305	2.471	6.107	.506	3.618
	23	22.672	2.908	8.457	.348	1.697
Fat mass	19	11.470	5.922	35.074	.867	.246
	20	9.233	4.815	23.191	.889	1.021
	21	11.125	4.572	20.905	1.253	4.520
	22	10.958	3.859	14.895	1.120	5.260
	23	10.611	4.795	22.998	.574	1.394
Muscle mass	19	59.658	7.077	50.092	.143	.779
	20	57.758	8.448	71.384	-.534	.925
	21	59.616	6.426	41.304	-.227	-.111
	22	59.377	6.937	48.122	-.027	-.734
	23	59.747	8.178	66.892	-.220	-.966
Bone mass	19	3.126	.353	.125	.121	1.055
	20	3.050	.428	.184	-.679	1.250
	21	3.119	.312	.098	-.310	-.027
	22	3.113	.346	.120	-.063	-.687
	23	3.138	.401	.161	-.254	-.762
Hydric mass	19	44.335	4.429	19.619	.265	.992
	20	43.650	7.325	53.668	.324	1.710
	21	44.058	3.910	15.293	-.075	.316
	22	43.697	4.182	17.492	.102	-.531
	23	44.644	6.297	39.659	1.014	1.782

SD- Std. Deviation, Min. – Minimum, Max. - Maximum.

Table II
Descriptive statistics of body composition parameters of female groups

Parameters	Age	Mean	SD	Variance	Skewness	Kurtosis
Height	19	162.500	7.628	58.194	-.053	-.767
	20	163.928	7.967	63.476	.047	-1.592
	21	164.117	6.118	37.440	-.418	-.817
	22	162.794	5.525	30.532	.148	-.943
	23	164.916	6.385	40.775	.012	-.479
Weight	19	55.562	7.809	60.986	.647	-.731
	20	57.550	6.034	36.416	.342	-.387
	21	59.629	10.665	113.751	.077	-.588
	22	58.261	9.256	85.685	1.093	.370
	23	61.050	14.535	211.288	.789	-.513
BMI	19	20.987	1.918	3.680	.193	-.331
	20	21.457	2.276	5.183	-.175	-.672
	21	21.982	2.908	8.462	.652	-.259
	22	21.891	2.560	6.555	1.041	.137
	23	22.250	4.224	17.844	.980	-.203
Fat mass	19	11.575	4.889	23.910	.853	-.568
	20	14.057	3.804	14.475	.226	-.285
	21	14.770	7.787	60.649	.499	-.182
	22	13.170	7.198	51.815	1.199	.552
	23	16.175	10.245	104.976	.898	-.421
Muscle mass	19	41.756	3.224	10.395	.528	-.188
	20	44.942	10.318	106.478	1.825	2.044
	21	42.588	3.224	10.397	-.357	-1.166
	22	42.805	2.710	7.348	.030	-.935
	23	42.575	4.301	18.499	.263	-.848
Bone mass	19	2.243	.189	.036	.344	-.462
	20	2.200	.149	.022	.000	-1.453
	21	2.300	.177	.032	-.552	-.980
	22	2.282	.154	.024	.000	-1.202
	23	2.283	.203	.041	.111	-1.078
Hydric mass	19	30.787	2.647	7.011	.544	-.201
	20	30.478	2.386	5.697	-.171	-.858
	21	31.517	2.744	7.531	-.406	-1.105
	22	31.594	2.286	5.230	.121	-.813
	23	31.575	3.644	13.285	.319	-.826

SD- Std. Deviation, Min – Minimum, Max. - Maximum

Table III

Mean differences in body composition between ages and genders.

Parameters	Gender	Female				Male			
	Age	20	21	22	23	20	21	22	23
Height	19	-1.42	-1.61	.88	-2.41	-1.28	-0.53	-1.17	-4.34
	20	-	-.18	2.30	-.98	-	0.75	0.11	-3.06
	21	-	-	2.49	-.79	-	-	-0.64	-3.82
	22	-	-	-	-3.29	-	-	-	-3.17
Weight	19	-1.99	-4.07	-1.45	-5.49	4.20	0.50	0.01	0.67
	20	-	-2.08	0.54	-3.50	-	-3.71	-4.19	-3.54
	21	-	-	2.62	-1.42	-	-	-0.49	0.17
	22	-	-	-	-4.04	-	-	-	0.66
BMI	19	-0.47	-0.99	-0.78	-1.26	1.74	0.23	0.26	1.42
	20	-	-0.53	-0.31	-0.79	-	-1.50	-1.48	-0.32
	21	-	-	0.22	-0.27	-	-	0.03	1.19
	22	-	-	-	0.48	-	-	-	1.16
Fat mass	19	-2.48	-3.20	-0.39	-4.60	2.24	0.33	0.28	1.03
	20	-	-0.71	2.10	-2.12	-	-1.91	-1.96	-1.21
	21	-	-	2.81	-1.40	-	-	-0.05	0.70
	22	-	-	-	-4.21	-	-	-	0.75
Muscle mass	19	-3.19	-0.83	-1.01	-0.82	1.90	0.18	-0.24	-0.31
	20	-	2.35	2.18	2.37	-	-1.90	-1.72	-2.14
	21	-	-	-0.18	0.01	-	-	-0.41	-0.49
	22	-	-	-	0.19	-	-	-	-0.08
Bone mass	19	0.04	-0.06	-0.02	-0.04	0.08	0.01	-0.02	-0.03
	20	-	-0.10	-0.06	-0.08	-	-0.06	-0.09	-0.11
	21	-	-	0.04	0.02	-	-	-0.03	-0.05
	22	-	-	-	-0.02	-	-	-	-0.01
Hydric mass	19	0.31	-0.73	-0.71	-0.79	0.69	0.35	0.65	-0.65
	20	-	-1.04	-1.02	-1.10	-	-0.34	-0.04	-1.34
	21	-	-	0.02	-0.06	-	-	0.30	-1.00
	22	-	-	-	-0.08	-	-	-	-1.30

Table IV

ANOVA analysis of parameters of body composition according to ages.

Parameters	Gender	Sum of Squares	Mean Square	F	p
Height	Female	172.432	43.108	.938	.444
	Male	281.649	70.412	1.111	.354
Weight	Female	527.798	131.949	1.382	.244
	Male	421.838	105.459	.726	.575
BMI	Female	27.751	6.938	.889	.472
	Male	77.309	19.327	2.412	.042
Fat mass	Female	397.484	99.371	2.087	.046
	Male	109.634	27.409	1.175	.325
Muscle mass	Female	164.923	41.231	1.351	.255
	Male	106.453	26.613	2.470	.048
Bone mass	Female	.176	.044	1.441	.224
	Male	.213	.053	.378	.824
Hydric mass	Female	28.260	7.065	.936	.445
	Male	29.946	7.487	.235	.918

F- Statistically test the equality of means, p – level of statistically significant.

In Table III, we conducted a statistical analysis highlighting the differences in the arithmetic means of body composition parameters based on gender and age. Analyzing the results, we observe that the greatest height difference was recorded between the ages of 21 and 22

for males, with a decrease of -3.29 cm, and between 19 and 23 for females, with a difference of 4.34 cm. The most significant difference in weight was 5.49 kg between the ages of 19 and 23 for males and 4.34 kg between the same age groups for females. The BMI showed the largest

difference of 1.26 between 19- and 23-year-old male subjects, while for females, the highest difference was 1.50 between 20- and 22-year-old subjects. Fat mass recorded the most significant differences among males between 19 and 23 years old, with a variation of 4.60 kg, while for females, the highest difference was 2.24 kg between the 19- and 20-year-old groups. Muscle mass showed the greatest average differences between 20- and 23-year-old males, with a difference of 2.37 kg, while for females, the most significant variation was between the 19-20-21 age groups, with a difference of 1.90 kg. Bone mass recorded the highest differences between the 20- and 23-year-old groups, varying by 0.8 kg for males and 0.11 kg for females. The results for hydric mass indicate that the most significant differences were recorded between the 20- and 23-year-old groups for both genders. The BMI values in this study for both male and female groups reflect a standard index between 18.5 and 24.

The ANOVA analysis in Table IV highlights that statistically significant differences among the five male age groups were recorded only for the BMI parameter ($p = 0.042$) and muscle mass ($p = 0.048$). For the five female age groups, only the fat mass parameter showed statistically significant differences ($p = 0.046$). For the other analyzed body composition parameters, no statistically significant differences were found between the five age groups or between genders.

Discussion

In this study, we focused on identifying gender and age-related differences in body composition parameters among students aged 19-23. The results highlight significant differences in the female group only for fat mass, while no statistically significant differences were found for the other body composition parameters between age groups. In the male groups, significant age-related differences were observed only for the muscle mass parameter, whereas the other body composition parameters did not show statistically significant differences.

The results indicate differences in only three parameters (BMI, fat mass, and muscle mass). In contrast, no significant differences were observed in the other parameters, reflecting a uniform and normal morphological development among students aged 19-23. Our findings align with previous studies that identify differences in body composition among young student samples (Pescari et al., 2024; López-Sánchez et al., 2019; Yahia et al., 2016; Zaccagni et al., 2014).

Numerous studies have analyzed young populations' body composition based on their lifestyle level, sedentary behavior, or physical activity (Jin et al., 2019; Coman et al., 2024). Additionally, other studies have focused on identifying the impact of body composition imbalances on the incidence of metabolic and cardiovascular diseases, among others (Torres et al., 2023; Hervás et al., 2018; Morrell et al., 2012; Bertias et al., 2003).

Further studies have investigated obesity and overweight levels about young populations' physical and mental performance (Beaudry et al., 2019; Bahat et al., 2020). Recent research has emphasized the importance of adopting a healthy and balanced lifestyle, both nutritionally

and in terms of physical activities, to optimize students' quality of life and academic performance (Szemik et al., 2024; Enderle et al., 2023; Redondo-Flórez et al., 2022).

Study limitations. The relatively small number of subjects compared to the overall student population; environmental and social factors were not analyzed; physical and mental fitness levels were not assessed; nutritional aspects were not examined.

Practical implications of the study. Understanding gender differences facilitates the assessment of developmental status and classification within specific body composition norms based on gender and age; longitudinal analysis over five years (19-23 years) allowed for a better understanding of the dynamics of body composition parameters about gender; expert recommendations regarding nutrition and the implementation of an active lifestyle among students should consider morphological characteristics, physical activity levels, and lifestyle facto

Conclusions

1. Analyzing the differences recorded between the groups relative to age, we observe a positive dynamic in all body composition parameters for both genders, with the average values falling within the reference limits for physical development according to age and gender.

2. Statistically significant differences among the five male age groups were recorded only for the BMI and muscle mass parameters; for the five female groups, relative to age, only the fat mass parameter showed statistically significant differences.

3. The following body composition parameters did not show statistically significant differences for age and gender: height, weight, bone mass, and hydric mass.

Conflict of interest

There is nothing to declare.

References

- Alpaslan G, Bekir T, Badau A. The effects of three different types of exercises on aerobic and anaerobic power. *Phys Educ Stud.* 2017;21(4):152-157. doi:10.15561/20755279.2017.0401.
- Badau D, Badau A, Trambitas C, Trambitas-Miron D, Moraru R, Stan AA, Oancea BM, Turcu I, Grosu EF, Grosu VT, et al. Differences between Active and Semi-Active Students Regarding the Parameters of Body Composition Using Bioimpedance and Magnetic Bioresonance Technologies. *International J Environ Res Public Health.* 2021;18(15):7906. doi:10.3390/ijerph18157906.
- Badau D, Talaghir L, Rus V, Badau A. The impact of the needs and roles of nutrition counselling in sport. *Human Sport Med.* 2018;18(2):88-96. doi:10.14529/hsm180208.
- Bahat G, Tufan A, Kilic C, et al. Cut-off points for height, weight and body mass index adjusted bioimpedance analysis measurements of muscle mass with use of different threshold definitions. *Aging Male.* 2020;23(5):382-387. doi:10.1080/13685538.2018.1499081.
- Bahat G, Tufan A, Kilic C, et al. Cut-off points for weight and body mass index adjusted bioimpedance analysis measurements of muscle mass. *Aging Clin Exp Res.* 2019;31(7):935-942. doi:10.1007/s40520-018-1042-6.
- Beaudry KM, Ludwa IA, Thomas AM, Ward WE, Falk B, Josse

- AR. First-year university is associated with greater body weight, body composition and adverse dietary changes in males than females. *PLoS One*. 2019;14(7):e0218554. doi:10.1371/journal.pone.0218554.
- Beaudry KM, Ludwa IA, Thomas AM, Ward WE, Falk B, Josse AR. First-year university is associated with greater body weight, body composition and adverse dietary changes in males than females. *PLoS One*. 2019;14(7):e0218554. doi:10.1371/journal.pone.0218554.
- Ben Mansour G, Kacem A, Ishak M, Grélot L, Ftaiti F. The effect of body composition on strength and power in male and female students. *BMC Sports Sci Med Rehabil*. 2021;13(1):150. doi:10.1186/s13102-021-00376-z.
- Bertsias G, Mammias I, Linardakis M, Kafatos A. Overweight and obesity in relation to cardiovascular disease risk factors among medical students in Crete, Greece. *BMC Public Health*. 2003;3(1):3. doi:10.1186/1471-2458-3-3.
- Coman MG, Adam AM, Gheorghe C, et al. Body composition and cardiorespiratory fitness characteristics among female university students: a cross-sectional study. *Balneo PRM Res J*. 2024;15(4):753-753. doi:10.12680/balneo.2024.753.
- Deliens T, Deforche B, Chapelle L, Clarys P. Changes in weight and body composition across five years at university: A prospective observational study. *PLoS One*. 2019;14(11):e0225187. doi:10.1371/journal.pone.0225187/.
- Enderle J, Reljic D, Jensen B, Peine S, Zopf Y, Bosy-Westphal A. Normal values for body composition in adults are better represented by continuous reference ranges dependent on age and BMI. *Clin Nutr*. 2023;42(5):644-652. doi:10.1016/j.clnu.2023.03.006.
- Hervás G, Ruiz-Litago F, Irazusta J, Fernández-Atutxa A, Fraile-Bermúdez AB, Zarrazquin I. Physical Activity, Physical Fitness, Body Composition, and Nutrition Are Associated with Bone Status in University Students. *Nutrients*. 2018;10(1):61. doi: 10.3390/nu10010061.
- Jaremków A, Markiewicz-Górka I, Hajdusianek W, Czerwińska K, Gać P. The Relationship between Body Composition and Physical Activity Level in Students of Medical Faculties. *J Clin Med*. 2023;13(1):50. doi: 10.3390/jcm13010050.
- Jin M, Du H, Zhang Y, et al. Characteristics and reference values of fat mass index and fat free mass index by bioelectrical impedance analysis in an adult population. *Clin Nutr*. 2019;38(5):2325-2332. doi:10.1016/j.clnu.2018.10.010.
- López-Sánchez GF, Radzimiński Ł, Skalska M, et al. Body Composition, Physical Fitness, Physical Activity and Nutrition in Polish and Spanish Male Students of Sports Sciences: Differences and Correlations. *Int J Environ Res Public Health*. 2019;16(7):1148. doi:10.3390/ijerph16071148.
- Maïmoun L, Mura T, Leprieur E, Avignon A, Mariano-Goulart D, Sultan A. Impact of obesity on bone mass throughout adult life: Influence of gender and severity of obesity. *Bone*. 2016;90:23-30. doi:10.1016/j.bone.2015.11.020.
- Morrell JS, Lofgren IE, Burke JD, Reilly RA. Metabolic syndrome, obesity, and related risk factors among college men and women. *Journal of American College Health*. 2012;60(1):82-89. doi:10.1080/07448481.2011.582208.
- Pescari D, Mihuta MS, Bena A, Stoian D. Comparative Analysis of Dietary Habits and Obesity Prediction: Body Mass Index versus Body Fat Percentage Classification Using Bioelectrical Impedance Analysis. *Nutrients*. 2024;16(19):3291. doi: 10.3390/nu16193291.
- Redondo-Flórez L, Ramos-Campo DJ, Clemente-Suárez VJ. Relationship between Physical Fitness and Academic Performance in University Students. *Int J Environ Res Public Health*. 2022;19(22):14750. doi:10.3390/ijerph192214750.
- Szemik S, Zieleń-Zynek I, Szklarek E, Kowalska M. Prevalence and determinants of overweight or obesity among medical students over a 2-year observation. *Front Nutr*. 2024;11:1437292. doi:10.3389/fnut.2024.1437292.
- Torres L, Caciula MC, Tomoiaga AS, Gugu-Gramatopol C. Correlations between Mental Health, Physical Activity, and Body Composition in American College Students after the COVID-19 Pandemic Lockdown. *Int J Environ Res Public Health*. 2023; 20(22):7045. doi:10.3390/ijerph20227045.
- Versic S, Idrizovic K, Ahmeti GB, Sekulic D, Majeric M. Differential Effects of Resistance- and Endurance-Based Exercise Programs on Muscular Fitness, Body Composition, and Cardiovascular Variables in Young Adult Women: Contextualizing the Efficacy of Self-Selected Exercise Modalities. *Medicina (Kaunas)*. 2021;57(7):654. doi:10.3390/medicina57070654.
- Yahia N, Wang D, Rapley M, Dey R. Assessment of weight status, dietary habits and beliefs, physical activity, and nutritional knowledge among university students. *Perspect Public Health*. 2016;136(4):231-244. doi:10.1177/1757913915609945.
- Zaccagni L, Barbieri D, Gualdi-Russo E. Body composition and physical activity in Italian university students. *J Transl Med*. 2014;12(1):120. doi:10.1186/1479-5876-12-120.