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Body Composition and Cardiorespiratory Fitness Characteristics Among Female University Students: A Cross-Sectional Study

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Abstract: Obesity and body composition are crucial indicators of health, especially among young adults whose lifestyle changes during university years can impact physical well-being. This study examines obesity levels and body composition parameters in female university students, hypothesizing that they exhibit elevated body fat percentages compared to health standards, likely due to a sedentary lifestyle. A secondary hypothesis posits a correlation between physical activity levels and body composition, anticipating higher fat mass in students with low physical activity levels. The study included 258 female students, aged 18-23, from seven faculties at the University "Dunărea de Jos" of Galați. Body composition metrics, such as total body water, protein, minerals, body fat mass, skeletal muscle mass, and BMI, were assessed using the InBody 720 (Biospace, Korea). Cardiovascular fitness was evaluated through the Ruffier Test, a widely accepted measure in Europe. SPSS 26 software was used for statistical analysis, applying Skewness and Kurtosis to assess data distribution, while Pearson correlation evaluated relationships between physical activity and body composition. The analysis revealed a significant trend toward elevated fat mass and obesity indicators. The average body fat mass was 32.3%, substantially above the healthy standard of 23%, and 52.3% of participants were classified as having excessive body fat. BMI showed 38% of students in the overweight or obese range. Waist-to-hip ratios highlighted prevalent central adiposity, with a mean of 0.918, exceeding recommended limits for women. A positive correlation was found between lower physical activity and increased fat mass, supporting Hypothesis 2. Findings indicate a high prevalence of obesity-related parameters among female university students, likely linked to lifestyle changes. These results emphasize the importance of health promotion efforts to encourage physical activity and healthy habits in this population, suggesting a role for bioelectrical impedance analysis as a valuable tool in university health assessmentsy.

Keywords: Obesity; Body Composition; Physical Activity; Bioelectrical Impedance Analysis; Sedentary Lifestyle; Cardiovascular Health; Health Risk Factors; Young Female Adults

1. Introduction

According to Sillanpä et al. throughout life, human body composition changes aging processes that are influenced by genetic factors, but also by external factors such as nutrition, physical activity, and medical conditions [1]. Optimal body composition differs from one individual to another, but low-fat mass (FM) is considered beneficial for maintaining health, supporting functional capacity, and improving physical performance [1].

Globally, sedentary lifestyles and high-calorie diets are becoming increasingly common, a phenomenon attributed to industrialization, urbanization, and technological innovations in developing countries [2].

Overweight and obesity are characterized by an abnormal or excessive accumulation of body fat, which can have severe health consequences. Today, the main health challenges are the continuing increase in the number of overweight people and the risks associated with an aging population [3-5].

Obesity contributes significantly to a reduced quality of life and is an independent risk factor for many diseases, including cancer, depression, and anxiety, and excess abdominal fat significantly influences the risk of cardiovascular disease, metabolic disorders, and diabetes mellitus [6,7]. In addition, sedentary behavior among adults impairs cardiorespiratory fitness, balance, and muscle strength, factors that may contribute to the development of sarcopenia over time [8,9].

In young adulthood, the rate of overweight and obesity increases significantly, almost doubling among women from 17.1% to 31.9% in the 12-19 and 20-39 age groups respectively [10]. According to data collected by the World Health Organization (WHO) Global Health Observatory in 2016, more than 1.9 billion adults were overweight, of which 650 million were obese. These statistics indicate that the global prevalence of obesity nearly tripled between 1975 and 2016 [11].

In the United States and China, obesity among children and adults has reached alarming levels and is considered a rapidly growing and aggressive epidemic, which emphasizes the need for valid tools to assess body composition. In China, approximately 46% of adults and 15% of children are classified as obese or overweight [12,13]. Trends are also worrying for citizens in the United States, where it is estimated that 78% of adults will be overweight or obese by 2030 [14].

For the European region, the latest data from the WHO European Regional Obesity Report 2022 indicates a prevalence of overweight and obesity of 59% among adults (63% men and 54% women) [15]. A 2017-2018 survey of 10,810 participants, representative of the general adult population in 12 European countries, shows that obesity prevalence was lowest in Italy (7.5%) and France (8.8%) and highest in Greece (19.7%), followed by Romania (21.1%) [16].

Students represent a distinct category of young people in the final stage of biological development, preparing for the responsibilities of adult life [17]. University admission is a long-awaited but challenging and often stressful time for many young adults [18]. This period marks a critical transition between the high school and university environment, as students separate from the family nucleus, undergo lifestyle changes, become increasingly independent, and try to adapt to both environmental changes and academic demands [18,19,20,21,22,23]. Time management, busy schedules, and study-related stress can be factors that affect health awareness and concern [24]. University students are a group of young adults who have greater autonomy over food choices but often face limited financial resources. Numerous studies show that students in various fields of study in both the USA and Australia are overweight or obese and the majority of them are not physically active (38% in Australia and 54% in the USA) [25].

Studies show that the prevalence of obesity and overweight is significantly higher among young adults compared to other age groups [26,27]. This stage of life is characterized by unhealthy eating habits, high fast-food consumption, and lack of physical activity, which may lead to an increased risk of cardiovascular and metabolic diseases in the long term [28].

Several studies associate obesity with low levels of physical activity [29]. A study based on a systematic literature review and meta-analysis of longitudinal data emphasizes that physical activity decreases in the transition from adolescence to young adulthood [30]. Also, the increasing use of technology by the younger generation is one of the main factors negatively influencing physical activity levels and indirectly affecting overall health status, which is true for both genders [31].

For optimizing health, obesity management is significantly influenced by the level of weekly physical activity, the quality and quantity of food consumed, and the adoption of an active lifestyle [32].

In their desire to maintain a harmonious body, female students are often preoccupied with their physical appearance, many of them trying to reduce body weight through diet rather than regular exercise, despite the lack of accurate and concrete information in this direction [33,34]. A recent study emphasizes that any form of physical activity is beneficial for improving body composition, showing that regular physical activity favors a reduction in fat mass and an increase in muscle and protein mass [35]. These observations suggest the need for an in-depth analysis of the relationships between changes in body composition and the lifestyles adopted by students [36].

Given the state of alert generated by the increasing prevalence of obesity in recent years, it is essential to identify and analyze specific body composition parameters such as total body weight (BW), body mass index (BMI), FM, fat mass percentage, fat-free mass percentage and total body water level [37,38].

Body composition analysis plays a crucial role in a variety of professional and medical fields, with applications in nutritional monitoring and assessment of conditions such as obesity, sarcopenia, osteoporosis, or body hydration. This analysis consists of describing and quantifying the components that make up the human body, allowing a precise approach to health assessment.

At the molecular level, the human body is composed of four main components: water, fats, proteins, and minerals, usually arranged in descending order of quantity [39,40,41,42].

Body composition can change as a result of growth and development processes, dietary habits - especially when there is a mismatch between nutrient intake and physiological requirements - exercise, and as we age [43,44,45]. In a study in a focus group of overweight young adult women, short-term High-Intensity Interval Training (HIIT) on a college campus was shown to lead to significant improvements in body composition, cardiovascular fitness, and psychological well-being [46].

Both men and women are prone to obesity, but the incidence and health consequences vary between the two sexes. For example, men and women differ in their patterns of fat accumulation and mobilization, in their use of fat as an energy source, and in the negative impact of excessive or insufficient fat stores. These variations may reflect evolutionary adaptations associated with differences in sex-specific reproductive processes [47].

In terms of body composition, women generally have a higher percentage of fat mass than men, who have proportionally more muscle mass. The increased fat mass in women is predominantly distributed around the hips and thighs, thus contributing to protection against metabolic disorders such as type 2 diabetes and atherosclerosis. For most individuals, the percentage of body fat tends to increase gradually between the ages of 20 and 25, continuing until around the age of 65. Muscle mass, on the other hand, peaks around the age of 30, after which a gradual decline begins, estimated at 20-40% by the age of 70 [48,49,50].

BMI is a widely used indicator to measure obesity and obesity rates [51,52]. It consists of a ratio obtained by dividing body weight (kg) by the square of height (cm), the results of which provide the possibility to categorize test subjects into different groups (underweight, normal weight, overweight, and obesity) [53].

There are currently multiple techniques for assessing body composition, ranging from simple indirect measurements to complex and direct volumetric methods. Thus, bioelectrical impedance analysis (BIA) is commonly used due to its accessibility and non-invasiveness, requiring minimal skin exposure to the test subjects [54,55,56]. BIA assesses body composition using an undetectable electric current, relying on differences in tissue water content, which generate variations in resistance and reactance to currents of different frequencies. Tissues that are rich in water and electrolytes, such as muscle, conduct electric current more efficiently, while tissues that lack water, such as fat and bone, have low conductivity. Thus, current resistance provides values for total body water and allows estimation of lean and fat mass [57,58].

In addition to BIA analysis, other methods are available to assess body composition, including dual X-ray absorptiometry (DXA), displaced air plethysmography (Bod Pod), magnetic resonance imaging (MRI), and computed tomography (CT). Comparative studies between these methods, using devices such as Inbody 720, DXA, Omron, and Bod Pod, have shown that all are acceptable in assessing body composition [59,60]. Also, the software TANITA MC580 and TANITA PRO [61] and anthropometric characteristics are other important elements in BMI assessment [62]. Thus, the scientific literature contains few studies that have addressed exercise addiction, body perception, and the use of fitness technology monitoring in an interconnected manner, thus emphasizing the need for further research in this area [63].

The present study aims to analyze obesity levels and specific body composition parameters among young adult women using bioelectrical impedance analysis.

Hypothesis 1: Young adult women attending university have a higher prevalence of increased fat mass values compared to accepted health standards, as a result of a more sedentary lifestyle and behavioral changes during the transition to university life.

Hypothesis 2: There is a significant correlation between body composition (percentage of fat and lean body mass) and physical activity levels of young female students. It is anticipated that lower levels of physical activity are associated with increased fat mass values.

2. Materials and Methods

2.1. Participants

The study included a total of 258 young adults, aged between 18 and 23 years old, students at 7 faculties of the University "Dunărea de Jos" of Galati. Participants were selected based on clear inclusion and exclusion criteria. The inclusion criteria were: non-athletic young adult female students (18-23 years old), without serious medical conditions (e.g. cardiovascular disease, diabetes). Exclusion criteria included: menstruating young women, those with joint pain, those on a restrictive diet, or those taking medications that may influence weight.

2.2. Research Design

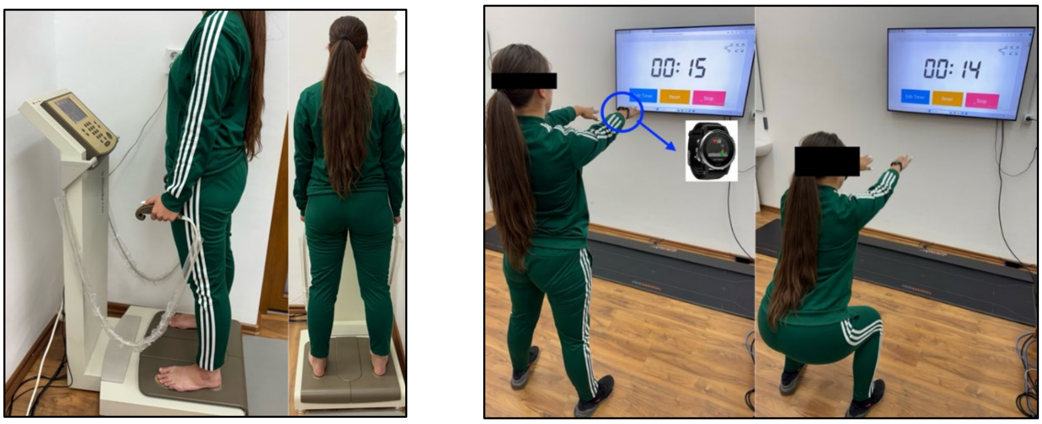
The research took place from February 1, 2023, to May 31, 2024, at the University Center of Physiotherapy and Medical Recovery of the University "Dunarea de Jos" of Galati.

For body composition analysis, the InBody 720/Biospace device (provenance: Korea) (Figure 1 (a)), which operates based on BIA technology, was used. The Inbobody 720/Biospace device (origin: Korea) provides us with important data related to body composition parameters such as Total body water; Intracellular Water (l); Extracellular Water (l); Protein (kg); Minerals (kg); Body Fat Mass (kg); Soft Lean Mass Fat Free Mass Skeletal muscle mass (kg); BMI; Body Mass Percent (%), Waist Hip Ratio etc.

To assess cardiovascular capacity and cardiovascular system response to exercise, we applied the Ruffier Test (figure 1 (b)), because it is a simple, valid, easy-to-apply test, without the need for special equipment, and is frequently applied in European countries [64,65]. This test consists of performing 30 squats for 45 seconds [66]. Three heart rate (HR) measurements are performed as follows: HR at rest (pre-test-P1), HR immediately after completion of the 30 squats (post-test-P2), and HR after 60 seconds (post-test-P3), and the final result is the following formula: R= (P1+P2+P3)-200/10.

[65,67] For higher accuracy we used a Garmin Fenix 5S watch for heart rate measurement [68].

For publication, note that the study was approved by the Scientific Research Ethics Committee (approval no. 1/10.01.2023) and conducted by the Helsinki Declaration.



(**a**) (**b**)

Figure 1. (**a**) Testing with the InBody 720 device; (**b**) Applying the Ruffier Test.

2.3. Statistical Analysis

For the centralization and statistical and mathematical processing of the data, we used the IMB SPSS (Statistical Package for the Social Sciences) version 26. To determine the skewness and the shape of the data distribution we calculated the statistical-mathematical indicators Skewness and Kurtosis, and to evaluate the relationships between variables we applied the Person correlation coefficient [69,70].

3. Results

Table 1 presents data on the age, height, and weight of the female university students involved in our study.

Table 1. Representation of participants

Group	Age	Height	Weight
Female	19.654 ± .950	164.744 ± 6.509	66.348 ± 15.985

Table 2. Main body composition parameters

Parameters	Mean	Std. Error	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Total body water (l)	32.001	.283	4.538	.633	.152	.050	.302
Intracellular Water (l)	19.802	.177	2.843	.623	.152	.045	.302
Extracellular Water (l)	12.238	.113	1.818	1.116	.152	2.902	.302
Protein (kg)	8.561	.077	1.229	.629	.152	.045	.302
Minerals (kg)	3.162	.029	.471	.654	.152	.091	.302
Body Fat Mass (kg)	22.667	.721	11.581	1.201	.152	1.144	.302
Soft Lean Mass	41.088	.369	5.930	.624	.152	.009	.302
Fat-free mass	43.711	.388	6.234	.635	.152	.044	.302
Skeletal muscle mass (kg)	23.824	.230	3.701	.619	.152	.045	.302

The values of the statistical-mathematical indicator Skewness for the parameters Total Body Water (l), Intracellular Water (l), Protein (kg), Minerals (kg), Soft Lean Mass, Fat-Free Mass (FMM), and Skeletal Muscle Mass (SMM) show a moderate skewness, with subjects with values significantly higher than the average. At the same time, for the parameters Extracellular Water (l) and Body Fat Mass (kg), the values obtained suggest a strong asymmetry, with some students having extreme values higher than the average, this being confirmed by the values of the Kurtosis statistic-mathematical indicator for these two parameters, indicating a tendency of the data to have extreme values.

Table 3. Representation and percentage of Protein and Minerals

Group	Levels	Protein		Minerals	
		Frequency	Percent (%)	Frequency	Percent (%)
Female	Normal	187	72.5%	235	91.1%
	Deficient	71	27.5%	23	8.9%

According to the nutritional assessment provided by the InBody 720 software (from Korea) (table 3), 72.5% of the students tested were within the normal range of body protein and only 27.5% were deficient in protein. In the case of minerals, 91.1% of the female students fall within a normal range and only 8.9% have a deficiency of minerals in the body.

Table 4. Obesity Diagnosis

Parameters	Mean	Std. Error	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
BMI	24.394	.339	5.452	1.179	.152	1.530	.302
PBF (%)	32.348	.560	8.994	.293	.152	-.563	.302
Waist Hip Ratio	0.918	.051	.814	15.893	.152	254.362	.302

Concerning the specific parameters of Obesity Degree (table 4) we can observe a moderate positive asymmetry only in the case of Percent Body Fat (%), and the arithmetic mean (32.348), compared to the standard values considered to be normal (23%) in women, exceeds by far the standard accepted value of this parameter. In the case of BMI and waist-hip ratio, the Skewness indicator suggests a strong asymmetry, with subjects with significantly higher values compared to the average. The arithmetic mean of the waist-hip ratio parameter (0.918) also exceeds the recommended reference range for women (0.75-0.85), which indicates a high proportion of fat stored in the waist and hip.

Table 5. BMI Classification

Group	Levels	Frequency	Percent (%)
Female	Underweight	15	5.8%
	Normal	145	56.2%
	Overweight	57	22.1%
	Obese 1	28	10.9%
	Obese 2	10	3.9%
	Severely Obese	3	1.2%

By calculating the percentages (table 5) to categorize the university students by BMI levels, we can observe a percentage of 5.8% for the Underweight level and 56.2% for the Normal level. Worryingly, the remaining 38% are categorized into the other categories indicating Overweight (22.1%), Obese 1 (10.9%), Obese 2 (3.9%), and Severely Obese (1.2%).

Table 6. Representation and percentage of Body Fat-nutritional evaluation

Group	Levels	Frequency	Percent (%)
Female	Normal	95	36.8%
	Deficient	28	10.9%
	Excessive	135	52.3%

Table 6 shows the percentage values calculated for the Body Fat-Nution Evaluation parameter levels. We observe that 36.8% of the students are categorized at the Normal level, 10.9% at the Deficient level, and an alarming 52.3% at the Excessive level. This last value suggests that more than half of the female university students evaluated have body fat well above normal.

Table 7. Weight Control

Parameters	Mean	Std. Error	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Target weight (kg)	60.057	.385	6.187	.889	.152	.609	.302
Weight Control (kg)	-6.300	.786	12.626	-.898	.152	.501	.302
Fat Control (kg)	-8.859	.683	10.964	-1.159	.152	1.158	.302
Muscle Control (kg)	2.557	.171	2.754	.919	.152	.122	.302
Inbody score (points)	68.818	.487	7.816	-1.093	.152	1.508	.302

The weight control-specific parameters (Table 7) provide interesting insights into body composition assessment and weight management. Following the calculation of the statistical-mathematical indicator Skewness we observe that the data have a moderate positive skewness distribution for the parameters Target Weight (kg) and Muscle Control (kg). For the parameters Weight Control (kg), Fat Control (kg), and InBody Score (points) the negative values suggest a negative skewness, with varying trends in the data distribution, suggesting the presence of a large number of subjects who received the recommendation to lose weight and reduce fat mass, resulting in a relatively large number of subjects who received a low score (InBody score).

Table 8. Representation and percentage of Weight Control

Group	Type	Frequency	Percent (%)
Female	Normal weight	6	2.3%
	To gain weight	93	36%
	To lose weitght	159	61.6%

Calculating the percentages for the parameter Weight Control (table 8) we observe that only 2.3% of the young adults have a normal weight, 36% should gain weight and 61.6% should lose weight. This tells us that the evaluated female students should pay more attention to lifestyle, both in terms of diet and physical activity.

Table 9. Representation and percentage of Fat Lose

Group	Type	Frequency	Percent (%)
Female	Normal fat	3	1.2%
	To gain fat	47	18.2%
	To lose fat	208	80.6%

For the parameter Fat Lose (table 9), only 1.2% of the female university students tested have a normal amount of fat, 18.2% of them should deposit/store fat, and a significant 80.6% of the female students should reduce fat intake.

Table 10. Representation and percentage of Muscle control

Group	Type	Frequency	Percent (%)
Female	Normal muscle	97	37.6%
	To gain muscle	161	62.4%
	To lose muscle	0	0%

In the case of this parameter (Table 10) we observe that 37.6% of the students have a normal musculature, but the remaining 62.4% should add muscle mass by practicing various physical activities regularly.

Table 11. Representation and percentage of Inbody Score

Group	Type	Frequency	Percent (%)
Female	Athletic Type	0	0
	Normal type	132	51.2%
	Weak type	126	48.8%

Based on a score provided by the InBody 720 software (from Korea) 51.2% of the university students tested are classified as Normal Type, the remaining 48.8% are classified as Weak Type, which denotes a low physical condition and a high risk of developing health problems (table 11).

Table 12. Additional parameters

Parameters	Mean	Std. Error	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Basal Metabolic Rate (kcal)	1315.508	8.463	135.929	.630	0.152	.009	.302
Obesity Degre (%)	112.895	1.634	26.240	.810	0.152	2.167	.302
Bone Mineral Content (kg)	2.632	.025	.405	.638	0.152	.190	.302
Body Cell Mass (kg)	28.359	.253	4.068	.622	0.152	.048	.302
Arm Circumference (cm)	30.111	.283	4.549	1.214	0.152	2.031	.302
Ruffier Test	15.303	.220	3.528	.061	0.152	-.805	.302

The values of the statistical-mathematical indicator Skewness indicate a moderate positive skewness of the parameters Basal Metabolic-Rate (kcal), Obesity Degree (%), Bone Mineral Content (kg), and Body Cell Mass (kg), most of the data being concentrated below the mean, with only a few higher values. For Arm Circumference (cm) the Skewness value suggests a strong positive skewness of the data distribution, with extremely high values. Concerning the Ruffier Test, the small value of Skewness indicates an almost symmetric distribution of the dates around the mean.

The mean value of 1315.508 kcal, obtained by our group of female university students for the Basal Metabolic Rate (kcal) indicator, falls within the recommended reference range for women of 1200-1500 kcal, which denotes an active metabolism of the subjects, an aspect explicable due to their age. At the same time, the average obtained for the parameter Bone Mineral Content (kg) is 2.632 kg, which is within the recommended range for women of 1.5 kg - 3.5 kg, indicating a healthy level of minerals in the bones. For the Arm Circumference (cm) parameter, the average of 30.111 cm exceeds the recommended range (25-30 in women), and considering the values of the Obesity Degree and Weight Control category-specific parameters, this parameter may reflect an accumulation of subcutaneous fat.

Table 10. Representation and percentage of Ruffier Test

Group	Ruffier Test levels	Frequency	Percent (%)
Female	Medium	13	5.0%
	Satisfactory	111	43.0%
	Unsatisfactory	134	51.9%

Regarding the Ruffier Test, only 13 female university students (5%) scored an average level, while 111 students scored a satisfactory level (43%). 51.9% of the students tested scored Unsatisfactory (>15), indicating low cardiovascular fitness and low physical activity.

Table 11. Correlations between body composition parameters

Parameters	Weight	TBW	BFM	SLM	FFM	SMM	BMI	PBF%	IS	IW	EW	BMR	WHR	OBD	BMC	BCM	AC
TBW	.808**																
BFM	.946**	.576**															
SLM	.796**	.991**	.564**														
FFM	.808**	.999**	.576**	.993**													
SMM	.808**	.999**	.577**	.990**	.998**												
BMI	.940**	.611**	.970**	.600**	.610**	.616**											
PBF	.794**	.314**	.930**	.304**	.315**	.317**	.888**										
IS	-.686**	-.196**	-.845**	-.185**	-.196**	-.193	-.748**	-.849**									
IW	.809**	.999**	.577**	.990**	.998**	1.000**	.617**	.317**	-.193**								
EW	.739**	.935**	.516**	.926**	.934**	.929**	.546**	.263**	-.165**	.929**							
BMR	.790**	.986**	.559**	.977**	.985**	.984**	.595**	.299**	-.183*	.984**	.921**						
WHR	.151*	0.115	.146*	.114	.115	.117	.164**	.136*	-.089	.118	.100	.112					
OBD	.914**	.582**	.950**	.572**	.581**	.589*	.979**	.876**	-.730**	.590**	.518**	.567**	.112				
BMC	.792**	.960**	.574**	949**	.962**	.956**	.576**	.340**	-.224**	.956**	.886**	.946**	.160**	.542**			
BCM	.808**	.999**	.577**	.990**	.998**	1.000*	.616**	.317**	-.192**	1.000**	.930**	.984**	.118	.589**	0.956**		
AC	.945**	.648*	.956**	639*	.647**	.656**	984**	.861**	-.729**	.657**	.575*	.632**	.159*	.961**	.603**	.657**	
RT	.331**	.081	.418**	.088	.083	.080	.364**	.419**	-.519**	.081	.051	.074	.114	.366**	.092	.080	.360**

TBW-Total Body Water (l); BFM-Body Fat Mass (kg); SLM-Soft Lean Mass; FFM-Fat Free Mass; SMM-Skeletal Muscle Mass (kg); BMI-Body Mass Index; PBF-Percent Body Fat (%); IS-InBody Score; IW-Intracellular Water (l); EW-Extracellular Water (l); BMR-Basal Metabolic Rate (kcal); WHR-Waist Hip Ratio; OBD-Obesity Degree; BMC-Bone Mineral Content (kg); BCM-Body Cell Mass (kg); AC-Arm Circumference (cm); RT-Ruffier Test.

0.00 ≤ r ≤ 0.09 no correlation; 0.10 ≤ r ≤ 0.39 - weak correlation; 0.40 ≤ r ≤ 0.69 - moderate correlation; 0.70 ≤ r ≤ 0.89 - strong correlation; 0.90 ≤ r ≤ 1.00 - very strong correlation

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

After calculating the Pearson correlation coefficient (table 11) between specific body composition parameters, the Ruffier test, and body composition parameters, we obtained a series of correlations that show that there are multiple relationships between these parameters. In this sense, we obtained 41 moderate correlations (0.40 ⩽ r ⩽ 0.69), 21 strong correlations (0.70 ⩽ r ⩽ 0.89), and 46 very strong correlations (0.90 ⩽ r ⩽ 1.00).

In Figure 2 (A-F) we plotted scatter plots to show the relationship between the following variables: Body Mass Index-Weight (A); Skeletal Muscle Mass-Total Body Water (B); Body Mass Index-Procent Body Fat (C); InBody Score-Body Mass Index (D); InBody Score-Ruffier Test; Weight-Total Body Water.

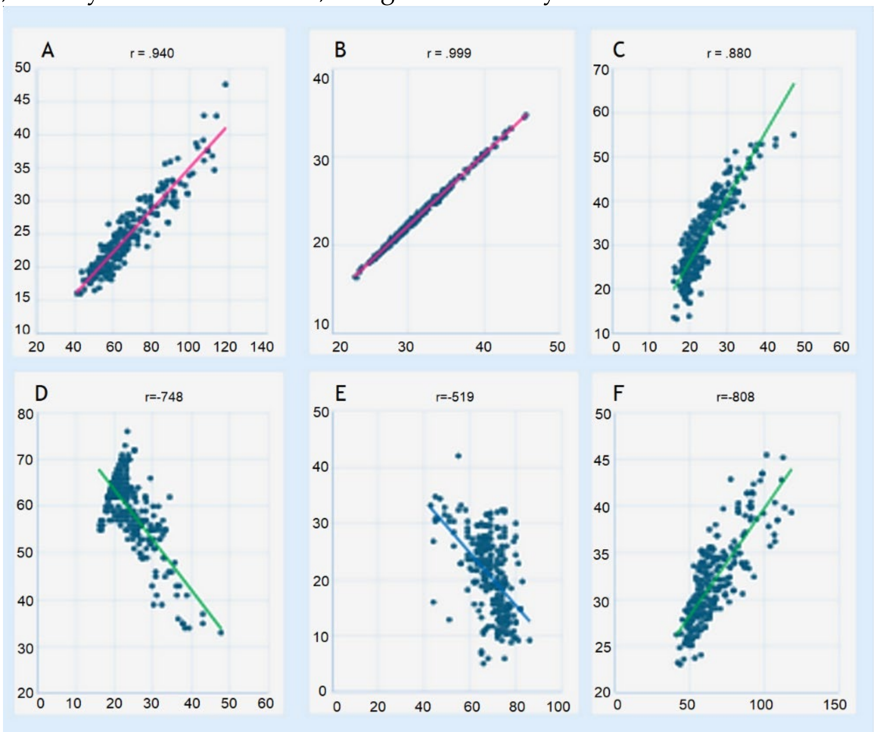


Figure 2. Pearson correlations between body composition parameters and the Ruffier test

In the case of the first correlation represented between the parameters BMI and Weight (2A) we observe a strong correlation (r = .940), so that the two variables are directly related, influencing each other, in the sense that as body weight increases, BMI will also increase. The correlation between the variables Skeletal Muscle Mass and Total Body Water (2B) (r = .999) is very strong, the increase in muscle mass is significantly associated with an increase in the amount of water in the body, the muscle being one of the most important water stores in the human body.

The value of the correlation between the parameters BMI and Body Fat Percentage (2C) (r=.880), indicates a strong correlation, thus, high values of BMI are directly influenced by high body fat percentage. Between the InBody Score and BMI (2D) variables, the Pearson correlation coefficient value () indicates a strong negative correlation, there being an inverse relationship between the two, in the sense that as the BMI value decreases, the InBody Score value will increase.

As for the correlation between InBody Score and Ruffier Test (2E), we observe a moderate negative correlation (r=-519), thus students with a better InBody Score, which reflects a healthy body composition, tend to have a better cardiovascular capacity, and therefore a faster recovery after exercise.

The positive correlation between the variables Weight and Total Body Water (r=808) suggests that the female university students enrolled in our study with a higher body weight tend to have a significant amount of water in their bodies. However, this body water amount may be influenced by several factors such as muscle mass level, body fatness, and hydration status of the subject. Considering the results presented above for the Obesity Degree and Weight Control category-specific parameters in our study, body fatness determines a higher amount of total body water.

4. Discussion

Currently, young students are faced with a constantly changing social dynamic, generating a complexity of lifestyle but also an imbalance in the intake of macro- and micronutrients, characterized by a high caloric density intake, contributing to a significant excess of body weight [71]. It is also imperative to study the differences in body composition, fitness levels, and lifestyles adopted by the new generations in different countries to develop a set of recommendations for promoting a healthy lifestyle among young adults, especially those in the transition period between high school and college [72]. Taking these considerations into account, quantifying obesity and at the same time determining body fat distribution is important for assessing and preventing the risks of the onset of possible diseases [73].

The likelihood of an individual being obese may be influenced by some genetic factors and the lifestyle he/she follows, and understanding the causes is an important step in creating a viable effective prevention policy for this disease [74]. Body weight in adults may undergo changes depending on the accumulated fat mass, and when monitoring these weight fluctuations it is necessary to take into account changes in muscle mass, body water level, body fat level, etc. [75]. With age the body fat percentage may increase although the body mass index may remain unchanged, this is due to the constant increase in fat mass and gradual decrease in lean mass [76]. Body fat levels are strongly correlated with increased mortality and risk of developing cardiovascular and metabolic diseases [77].

In research addressing the risks of obesity among university students, the proportion of overweight or obese young adults was higher compared to young adults [78]. At the same time in numerous nationally representative surveys representative of the respective country, large weight increases have been observed among young women aged 18-35 years compared to older women, which requires critical intervention [78].

In a study conducted on a group of students majoring in Sports Science in Spain aged 18-25 years, it was found that they showed a better cardiovascular profile and a lower fat percentage compared to students from other majors [79]. Another research that analyzed the relationship between body mass index and body fat percentage found a relationship between nutritional status and body fat percentage in women, and 35.3% of women had a high body fat percentage [80].

Another study conducted on a group of young adults aimed to analyze body composition about physical activity level and found a positive relationship between compliance with the recommended level of physical activity (150-300 minutes per week) and body fat volume [81]. Thus, physical exercise has a positive influence on body composition, including weight loss, loss of body fat, and increased muscle mass [82].

According to the guidelines issued by the American College of Sports Medicine (ACSM) and the American Dietetic Association, adults should engage in moderate physical activity for at least 30 minutes every day or most days of the week [83].

Exercise is usually performed as aerobic exercise, resistance exercise, or a combination of the two, and each form can have different effects on body composition [84]. Aerobic exercise is thought to be beneficial for body weight and fat mass reduction, while resistance exercise can help to increase lean mass and reduce body fat percentage [84].

Physical well-being is the complex interconnection between health, nutrition, and physical activity, each of which contributes to maintaining optimal body balance and improving quality of life [85].

The relationship between nutrition, health, and fitness is fundamental to improving quality of life, promoting a healthy lifestyle, and preventing disease. Thus, both diet and physical activity are key factors that directly influence body composition [86] and interventions can range from conservative management [87].

Given the increased values of body mass index and body fat level obtained by the female university students participating in our study, as well as the unsatisfactory Ruffier Test result of 51.9%, it is imperative to promote physical activity and a healthy lifestyle among female students. We also consider that a minimum level of weekly activity, together with a healthy diet, has a preventive character in the onset of possible diseases.

5. Conclusions

This study highlights the prevalence of obesity and elevated health risks related to body composition among female university students, underscoring the importance of lifestyle interventions during early adulthood. A significant proportion of participants presented high body fat percentages, exceeding recommended levels for optimal health, with many also exhibiting increased waist-to-hip ratios, an indicator linked to cardiovascular and metabolic risks. The findings reveal a substantial gap between participants' awareness of health risks and their physical activity levels, emphasizing the impact of sedentary habits on obesity rates and overall health in this demographic.

BIA proved effective in assessing body composition, offering valuable insights into obesity-related metrics beyond traditional measures like BMI. The study demonstrates that reliance on BMI alone may underestimate obesity-related risks by failing to consider fat distribution and muscle mass—both crucial factors in evaluating health outcomes.

Given the critical period of young adulthood for establishing long-term health habits, these results underscore the need for targeted health interventions in university settings. Increasing physical activity levels, promoting balanced diets, and implementing routine health assessments could play a pivotal role in mitigating obesity risks among female university students. Educational programs emphasizing the health impacts of body composition and the long-term benefits of physical fitness could encourage proactive lifestyle adjustments, ultimately reducing the prevalence of obesity-related conditions in later life.

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