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COMPARATIVE ANALYSIS OF BODY COMPOSITION OF FEMALES FROM THREE EUROPEAN COUNTRIES[1]

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Abstract: The aim of this study was to examine differences in body composition among girls from three European countries (Serbia, Italy, and Spain). Based on age, participants were divided into two categories: the first group included girls aged 15–19 years, while the second group consisted of those aged 20–24 years. The first group comprised a total of 113 participants (50 from Serbia, 24 from Spain, and 39 from Italy), whereas the second group included 167 participants (50 from Serbia, 81 from Spain, and 36 from Italy). Body composition was assessed using the InBody 230 device, which enabled the assessment of the following variables: body height, body weight, BMI, body fat percentage, muscle mass percentage, and waist-hip ratio. In the age group 15-19 years, results showed statistically significant differences among the countries in body height ($p < 0.05$) and waist-hip ratio ($p < 0.05$). In the age group 20–24 years, statistically significant differences were observed in all measured variables. Overall, the results indicate that differences in body composition among girls from Serbia, Italy, and Spain are more pronounced in the older age group (20–24 years) compared to the younger group (15–19 years), which is likely a consequence of cultural, lifestyle, and training factors, while also underscoring the importance of monitoring body composition during growth and maturation.

Keywords: obesity, health, exercise, Serbia, Spain, Italy

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Introduction

Obesity is one of the main health problems faced by modern society (Abarca-Gómez et al., 2017; Organization, 2016). It develops as a result of excessive intake of energy-providing nutrients. The consequence is the accumulation of fat deposits in the body beyond the level considered normal for age, sex, and body type (Ilić, Mumin, & Harhaji, 2003; Mednicinski, 2004). True obesity is defined when body weight exceeds the ideal weight by at least 20%, which in women corresponds to 36% of total body mass (Bukara-Radujković & Zdravković, 2009). In addition to its negative impact on health, obesity has psychological, physiological, and pathophysiological effects (Pelemis, Pelemis, Mitrovic, & Džinović-Kojić, 2014). It represents an important factor in the growth and development of the body and is particularly significant during early adolescence. The World Health Report (2000) (WHO, 2000) states that overweight is the fifth most serious risk factor for both developed and developing countries (Bukara-Radujković & Zdravković, 2009). According to the report of the International Obesity Task Force (IOTF), in the year 2000 (Lobstein & Jackson-Leach, 2007) about 10% (a total of 155 million) of young people aged 5 to 17 worldwide were overweight.

Barlett, Puhl, Hodgson, and Buskirk (1991) note that gender differences begin to appear after the age of 10. The transition period refers to the stage of life from late adolescence to full physical and psychosocial maturation into adulthood, lasting from ages 16 to 26. During this period, gender differences are also present, favoring the male population (Doknić, 2018). In adulthood, women are twice as likely to develop severe obesity (BMI ≥35 kg/m²) (Di Cesare et al., 2019). In women, higher body fat in kilograms and greater lean body mass have been recorded. In addition, during postmenopause, the risk further increases due to a decline in estrogen levels, leading to increased fat tissue, reduced muscle mass, and deterioration of overall health (Appelman, van Rijn, Ten Haaf, Boersma, & Peters, 2015; EUGenMed et al., 2016; Leeners, Geary, Tobler, & Asarian, 2017).

Body composition should be understood in the context of additional influencing factors, which broadly include cultural, social, and geographical aspects (Ćopić, Đorđević-Nikić, Rakić, Maksimović, & Dopsaj, 2019). More specifically, factors affecting body composition may include modernization, ongoing population migration, employment (particularly among middle-aged women), family dynamics, residence in urban or rural settings, and social class.

According to the World Health Organization (WHO, 2022) report for the European region, the adult obesity rate (overweight + obesity) across much of Europe is close to 60% for the period 2022–2025. Regarding the female population in the studies

conducted in 2022, high rates were reported in countries such as Ireland, Romania, and Croatia, while Spain and Italy ranked among the highest (Pellegrino et al., 2023).

In Spain, more than half of the adult population (≈ 53.6%) is overweight (HEALTH, 2022). This cardiovascular risk factor has been associated with lower social class and lower educational level (Sánchez-Cruz, Jiménez-Moleón, Fernández-Quesada, & Sánchez, 2013a), as well as with dietary habits, cultural practices, and the fact that excessive consumption of unhealthy foods often occurs outside the family environment, such as in schools and surrounding areas (Niemeier et al., 2006). Specific dietary factors include the consumption of sugary drinks and wine, as well as late-night meals after 10 p.m. Spain has recently proposed a new law regulating the advertising of unhealthy food and beverages aimed at children under 16 years of age (Government, 2022).

Child and adolescent obesity in Serbia, as in most countries in transition, has reached epidemic proportions in recent years. According to data from the Ministry of Health, in 2006, 11.6% of children and adolescents were moderately obese and 6.4% were obese, representing an increase of 3.4% and 2.0%, respectively, compared to 2000. The causes of excessive weight are linked to irregular dietary patterns (skipping snacks, excessive consumption of bread, insufficient intake of fruits and vegetables), a sedentary lifestyle (TV, phone use), as well as exemption from physical education classes and lack of participation in sports (Vlaški & Katanić, 2010).

Simple measurements for assessing body composition, such as skinfold thickness and body mass index (BMI), are easy to perform but carry a significant margin of error. Other methods require participant cooperation, sophisticated equipment, and skilled examiners. The most reliable method for assessing body composition is bioelectrical impedance analysis using the InBody 230 (Copic, Dopsaj, Ivanovic, Nesic, & Jaric, 2014; Ferrando-Terradez et al., 2023). BIA provides more reliable measurements of body composition, including body weight, total body water, fat mass, muscle mass, body fat percentage, and BMI.

Obesity is a 21st-century pandemic, with its impact being most significant among the youngest populations. Early prevention of obesity can help avoid many of its consequences. Comparative data from European countries come from various studies and sometimes employ different methodologies (e.g., age-standardized BMI, self-reported weights, sample-based studies), so direct comparisons are not always precise. For this reason, the aim of the present study is to examine differences in body composition among girls from three European countries (Serbia, Italy, and Spain), providing a basis for further recommendations to improve children's health.

Methods

Subjects

The study included 280 female participants from three European countries (Serbia – Belgrade, Italy - Parma, Spain - Valencia). Participants from each country were divided into two age groups: adolescents aged 15 to 19 years and young adults aged 20 to 24 years. In the adolescent group, there were 50 participants from Serbia (16.72 ± 1.51 years), 24 from Spain (18.75 ± 0.71 years), and 39 from Italy (16.39 ± 1.61 years). The young adult group consisted of 50 participants from Serbia (22.04 ± 1.31 years), 81 from Spain (21.88 ± 1.44 years), and 36 from Italy (21.78 ± 0.99 years). All participants were healthy, with no known medical conditions that could affect the measurement results. Prior to the study, participants were fully informed about the procedures and voluntarily signed written consent to participate. The research protocol was reviewed and approved by the Human Research Ethics Committee of the University of Valencia (protocol number 1944476). The study is registered in ClinicalTrials.gov (NCT05467280). All participants provided written informed consent in accordance with the principles of the Declaration of Helsinki.

Testing Protocol

Body composition measurements were conducted during a single experimental session. All assessments took place in the morning, between 8:00 and 11:00 a.m., following the participants' normal daily routines. All participants were previously instructed to avoid intense physical activity for at least 48 hours and to refrain from eating for two hours prior to the measurement. Body composition measurements in all three countries were carried out in 2022 using bioelectrical impedance analysis with the InBody 230. To ensure maximum reliability, participants were tested in underwear and were required to remove all metal jewelry, following the recommendation to avoid food intake for at least two hours before assessment. After entering basic data, participants stood on the device's metal footplates and held the handles with built-in electrodes, keeping their arms slightly away from the body at an approximate angle of 20° during the measurement. The InBody 230 body-composition analyzer demonstrates excellent repeatability and measurement precision, with reported test–retest reliability values reaching an ICC of 0.9995. When evaluated against DXA, which is considered the reference method, BIA measurements showed very strong agreement, with intraclass correlation coefficients ranging from 0.96 to

0.99 in individuals with normal body weight (Gibson, Holmes, Desautels, Edmonds, & Nuudi, 2008).

Variables

- Body Height (BH) – Measurements were performed using a Martin anthropometer, which has a measurement accuracy of 0.1 cm (Norton et al., 2000);
- Body Weight – Body mass was measured using bioelectrical impedance analysis (InBody 230), with a measurement accuracy of 0.1 kg;
- BMI – Body mass index (BMI), expressed in kg/m²;
- Body Fat (%) – Body fat percentage, expressed as %;
- Muscle mass (%) – Muscle mass percentage, expressed as %;
- Waist-hip ratio – Waist circumference (cm)/hip circumference (cm).

Statistical analyses

A descriptive statistical analysis provided means, standard deviation (SD), minimum (Min) and Maximum (Max). Differences between countries were assessed using one-way analysis of variance (ANOVA) to determine the presence of statistically significant differences in the measured variables. In cases where ANOVA indicated a statistically significant difference for a specific variable, an LSD post hoc test was conducted to identify within-group differences. The threshold for statistical significance was set at a 95% confidence level, $p = 0.05$. All statistical analyses were performed using Microsoft Office Excel (Microsoft Corp., Seattle, WA, USA) and SPSS for Windows, Release 17.0 (IBM, Armonk, NY, USA).

Results

Table 1 presents the descriptive statistics, including the arithmetic mean (Mean), standard deviation (SD), as well as the minimum (Min) and maximum (Max) values for all analyzed variables in both age groups of participants from Serbia, Spain, and Italy.

Table 1. Descriptive statistics of the main characteristics

		15-19 years					20-24 years				
	Country	**Mean**	**SD**	**Min**	**Max**	**N**	**Mean**	**SD**	**Min**	**Max**	**N**
Body Height (cm)	**Serbia**	169.88	5.74	157	186	50	169.00	5.97	156	180	50
	Spain	161.22	7.35	146.8	177.8	24	162.42	6.02	150.3	175.5	81
	Italy	162.79	6.51	147	176	39	165.83	5.78	150	178	36
Body Weight (kg)	**Serbia**	61.97	11.13	40	95.3	50	65.01	9.35	49.7	89.3	50
	Spain	60.02	9.61	43.2	81.9	24	61.66	11.88	44	102.1	81
	Italy	57.15	9.67	43.4	77.1	39	58.2	8.48	44	75.9	36
BMI (kg/m^2)	**Serbia**	21.46	3.73	16	33.4	50	22.78	3.25	16.8	34	50
	Spain	23.04	3.09	18.5	29.1	24	23.38	4.48	16.4	38.9	81
	Italy	21.53	3.17	15.2	28.7	39	21.1	2.74	16.9	27.9	36
Body Fat (%)	**Serbia**	25.82	8.83	3.00	47.5	50	27.69	7.33	9.7	48.9	50
	Spain	28.34	10.15	3.00	42.3	24	29.47	9.97	3.00	50	81
	Italy	26.03	8.32	4.4	47.9	39	23.91	6.91	10.4	42	36
Muscle mass (%)	**Serbia**	40.7	5.10	28.46	56.21	50	39.86	4.14	28.22	50.95	50
	Spain	39.4	6.65	30.49	57.28	24	38.6	5.92	27.19	56.87	81
	Italy	40.3	4.57	28.12	52.28	39	41.62	3.91	31.51	49.06	36
Waist-Hip Ratio	**Serbia**	0.88	0.06	0.75	1.03	50	0.90	0.05	0.79	1.03	50
	Spain	0.86	0.06	0.71	0.98	24	0.87	0.07	0.71	1.03	81
	Italy	0.83	0.06	0.76	0.95	39	0.83	0.05	0.76	1.02	36

In Table 2, the results of the one-way analysis of variance (ANOVA) showed statistically significant differences between countries in the variables Body Height ($F = 20.71$, $p < 0.01$) and waist-hip ratio ($F = 8.2$, $p < 0.01$) among participants aged 15–19 years. These results for the age group 15–19 years indicate that body composition variables are relatively homogeneous.

Table 2. Analysis of variance among participants from Serbia, Italy, and Spain for the 15–19-year age group

ANOVA

	Between Groups		Sum of Squares	df	Mean Square	F	Sig.
15-19 years	**Body Height (cm)**	Between Groups	1683.92	2	841.96	20.72	**0.000**
		Within Groups	4469.77	110	40.63		
		Total	6153.7	112			
	Body Weight (kg)	Between Groups	509.25	2	254.63	2.38	0.097
		Within Groups	11744.36	110	106.77		
		Total	12253.61	112			
	BMI (kg/m²)	Between Groups	45.42	2	22.71	1.94	0.148
		Within Groups	1284.94	110	11.68		
		Total	1330.35	112			
	Body Fat (%)	Between Groups	112.31	2	56.16	0.7	0.499
		Within Groups	8822.29	110	80.2		
		Total	8934.6	112			
	Waist-Hip Ratio	Between Groups	0.06	2	0.03	8.2	**0.000**
		Within Groups	0.41	110	0		
		Total	0.47	112			
	Muscle mass (%)	Between Groups	27.36	2	13.68	0.49	0.616
		Within Groups	3088.04	110	28.07		
		Total	3115.39	112			

In Table 3, the results of the one-way analysis of variance (ANOVA) showed statistically significant differences between countries for all variables among participants aged 20–24 years. Statistically significant differences were observed in body height, body mass, BMI, body fat percentage, waist-hip ratio, and muscle mass percentage ($p < 0.05$), indicating distinct anthropo-morphological profiles among participants from Serbia, Spain, and Italy. The largest statistically significant differences were found in body height ($F = 19.23$, $p < 0.01$) and waist-hip ratio ($F = 14.2$, $p < 0.01$), where the group effect was most pronounced.

Table 3. Analysis of variance among participants from Serbia, Italy, and Spain for the 20–24-year age group

ANOVA

		Between Groups	Sum of Squares	df	Mean Square	F	Sig.
20-24 years	Body Height (cm)	Between Groups	1363.26	2	681.63	19.23	**0.000**
		Within Groups	5813.45	164	35.45		
		Total	7176.7	166			
	Body Weight (kg)	Between Groups	981.48	2	490.74	4.45	**0.013**
		Within Groups	18091.34	164	110.31		
		Total	19072.82	166			
	BMI (kg/m^2)	Between Groups	129.36	2	64.68	4.45	**0.013**
		Within Groups	2385.47	164	14.55		
		Total	2514.83	166			
	Body Fat (%)	Between Groups	768.3	2	384.15	5.14	**0.007**
		Within Groups	12259.53	164	74.75		
		Total	13027.82	166			
	Waist-Hip Ratio	Between Groups	0.1	2	0.05	14.2	**0.000**
		Within Groups	0.58	164	0		
		Total	0.68	166			
	Muscle mass (%)	Between Groups	230.92	2	115.46	4.53	**0.012**
		Within Groups	4176.36	164	25.47		
		Total	4407.28	166			

In the 15–19 year age group, statistically significant differences were observed in body height and waist-hip ratio between the countries studied. Girls from Serbia were significantly taller compared to their peers from Spain (p = 0.000) and Italy (p = 0.000), while the difference between Spain and Italy was not significant (Table 4). Regarding the waist-hip ratio, participants from Serbia had slightly higher values compared to those from Italy (p = 0.000), indicating a statistically significant difference.

Table 4. LSD post hoc analysis – differences between Serbia, Spain, and Italy for the 15–19-year age group

Multiple Comparisons (15-19 years)

	LSD		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Body Height (cm)	Serbia	Spain	8.6633*	1.583	**0.000**	5.526	11.800
		Italy	7.0851*	1.362	**0.000**	4.386	9.784
	Spain	Italy	-1.5782	1.654	0.342	-4.856	1.699
Waist-Hip Ratio	Serbia	Spain	0.02630	0.015	0.086	-0.004	0.056
		Italy	0.05277*	0.013	**0.000**	0.027	0.079
	Spain	Italy	0.02647	0.016	0.098	-0.005	0.058

In the 20–24-year age group, more pronounced differences were identified in the analyzed variables between countries compared to the younger age category (Table 5). As in the younger group, differences in body height were observed among all three countries, with the greatest difference found between participants from Serbia and Spain (p = 0.000). Body mass was significantly higher in participants from Serbia compared to those from Italy (p = 0.003), while no significant differences were found between the other country pairs. Regarding BMI, participants from Italy differed significantly from those from Spain (p = 0.003) and Serbia (p = 0.046). Waist-hip ratio values were higher in participants from Serbia compared to those from both other countries (p = 0.000), indicating more pronounced central obesity. Concerning body fat percentage, participants from Italy had the lowest values and differed significantly from those from Serbia (p = 0.048) and Spain (p = 0.002). Additionally, participants from Italy differed significantly from those from Spain in muscle mass percentage (p = 0.03), while no difference was observed compared to participants from Serbia.

Table 5. LSD post hoc analysis – differences between Serbia, Spain, and Italy for the 20–24-year age group

Multiple Comparisons (20-24 years)

	LSD		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Body Height (cm)	Serbia	Spain	6.5840*	1.071	**0.000**	4.470	8.698
		Italy	3.1667*	1.301	**0.016**	0.597	5.736
	Spain	Italy	-3.4173*	1.193	**0.005**	-5.772	-1.062
Body Weight (kg)	Serbia	Spain	3.3523	1.889	0.078	-0.378	7.082
		Italy	6.8112*	2.296	**0.003**	2.278	11.344
	Spain	Italy	3.4590	2.104	0.102	-0.695	7.613
BMI (kg/m²)	Serbia	Spain	-0.5978	0.686	0.385	-1.952	0.757
		Italy	1.6772*	0.834	**0.046**	0.031	3.323
	Spain	Italy	2.2750*	0.764	**0.003**	0.767	3.783
Body Fat (%)	Serbia	Spain	-1.7794	1.555	0.254	-4.850	1.291
		Italy	3.7721*	1.890	**0.048**	0.041	7.504
	Spain	Italy	5.5515*	1.732	**0.002**	2.132	8.971
Waist-Hip Ratio	Serbia	Spain	0.03226*	0.011	**0.003**	0.011	0.053
		Italy	0.06883*	0.013	**0.000**	0.043	0.094
	Spain	Italy	0.03657*	0.012	**0.002**	0.013	0.060
Muscle mass (%)	Serbia	Spain	1.2592	0.908	0.167	-0.533	3.051
		Italy	-1.7594	1.103	0.113	-3.937	0.419
	Spain	Italy	-3.0186 *	1.011	**0.003**	-5.015	-1.023

Discussion

The aim of this study was to compare body composition characteristics of females from three European countries - Serbia, Italy, and Spain - across two age categories (15-19 and 20-24 years). The results clearly indicate that differences between countries exist, but these differences are largely influenced by age. In adolescence (younger group), only a few differences were observed, whereas in early adulthood (older group), more pronounced and consistent differences emerged between participants.

In both age categories, body height showed the most consistent results, with participants from Serbia being significantly taller than their peers from Italy and Spain. The difference in average height between women from Serbia compared to women from Spain and Italy is indeed present, amounting to approximately 5-7 cm (Cavelaars et al., 2000). These findings are fully consistent with European trends in body

height, according to which populations from the Balkans, Central, and Southeastern Europe are among the tallest, while populations from Mediterranean countries have lower average values (Grasgruber, Sebera, Hrazdíra, Cacek, & Kalina, 2016). Such differences can be largely attributed to genetic potential, as well as nutritional factors during childhood and adolescence.

The results of this study show that participants from Italy had, on average, lower BMI, body mass, and body fat percentage, whereas participants from Spain, particularly in the 20–24-year age group, exhibited higher values of these parameters and a more pronounced trend toward overweight. These findings are fully consistent with epidemiological data indicating a significant increase in the prevalence of excess body weight among adolescents and young women in Spain (Sánchez-Cruz, Jiménez-Moleón, Fernández-Quesada, & Sánchez, 2013b). In contrast, Italy - especially the northern and central regions - largely maintains the traditional Mediterranean dietary pattern, which has been shown to be associated with lower body fat percentage and a more favorable metabolic profile (Sofi et al., 2010; Bonaccio et al., 2014).

One of the most significant findings of this study relates to waist-hip ratio (WHR) values, which were highest among participants from Serbia in both age categories. WHR is a key parameter for assessing abdominal obesity and a strong predictor of metabolic risks, independent of BMI (Petrović et al., 2025). A study conducted in the Chianti region of Italy (1998–2000) reported an average WHR of 0.799 among women aged 20–44 years (Bartali se al., 2002). In a representative sample of middle-aged, working women in Spain, the average WHR was approximately 0.85 ± 0.06 (Herrero, García, Hanon, Barbero i González, 2022), whereas a study on a sample of women in Serbia recorded an average WHR of 0.78 ± 0.08. Comparisons indicate that participants from Serbia have statistically significantly higher WHR values compared to those from Italy ($p = 0.000$), which is confirmed by the present study. Studies by Faig (2014) show that the traditional Mediterranean diet is declining faster in Spain than in Italy. The increased consumption of ultra-processed foods, reduced intake of olive oil and fish (Abellan Aleman et al., 2016), higher consumption of sugary drinks among younger generations, and decreasing intake of fresh fruits and vegetables have contributed to Spanish women being among the most overweight in Europe, particularly in younger age groups (Herrera-Ramos et al., 2023). Italy, especially in the south, retains the traditional Mediterranean diet to a greater extent, whereas Serbia has never had a Mediterranean dietary pattern; its traditional diet was based on higher amounts of saturated fats, refined carbohydrates, and industrially processed foods - resulting in a different metabolic obesity profile, with a higher prevalence of abdominal obesity.

Physical activity and lifestyle significantly contribute to differences in body composition among countries. Epidemiological data indicate a higher prevalence of sedentary behavior among women in Spain, particularly in large cities (Armada, Sánchez-Alcaraz, Courel-Ibáñez, & Segarra-Vicens, 2024). This particularly affects abdominal fat, rather than overall obesity. In Italy, higher levels of daily informal physical activity are maintained (walking, cycling, recreational sports) (Bianconi et al., 2023), whereas in Serbia, physical activity levels are generally low (Todorovic et al., 2024). Considering the impact of sociological factors, Italy has an older population but a more traditional lifestyle with less stress and more structured daily habits. In Spain, women on average have children later, experience higher work-related stress, and live in more urbanized environments compared to Serbia. Serbia, in turn, has high stress levels coupled with a lower standard of living, which leads to different dietary patterns and weight gain trends.

Several limitations of the present study should be acknowledged. Although identical measurement protocols were applied across all countries, the sample size can be considered one of the key limitations of this study. In addition, factors influencing body composition, such as quality of life, including dietary habits and levels of physical activity, were not directly assessed and should be incorporated in future research.

Conclusion

The results of this study confirm the presence of significant differences in body composition among females from Serbia, Italy, and Spain, with these differences being more pronounced in early adulthood (20-24 years) than in adolescence (15–19 years). Participants from Serbia are characterized by greater body height and higher waist-hip ratio (WHR) values, indicating a greater predisposition to abdominal obesity. Italian participants exhibit the most favorable body profile, with lower BMI and body fat percentage, which may be associated with the preserved Mediterranean dietary pattern and a more active lifestyle. In contrast, participants from Spain, particularly in the older age group (20-24 years), showed a trend toward higher body mass and body fat. These findings suggest that age, dietary habits, physical activity, and broader socioeconomic factors play a key role in shaping body composition in young women across different European populations.

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Author Contributions:

Conceptualization: N.Ć.; Methodology: N.Ć.; Data curation: N.Ć., S.P.; Formal analysis: N.Ć.; Investigation: N.Ć., S.P., I.F.-T., M.E.-B.; Writing – original draft: N.Ć., S.P., I.F.-T., M.E.-B., N.P.; Writing – review & editing: N.Ć., S.P. All authors have read and agreed to the published version of the manuscript.

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