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ANTHROPOMETRIC AND PHYSICAL FITNESS DIFFERENCES BETWEEN POLISH AND ROMANIAN PHYSICAL EDUCATION STUDENTS: A SEX-SPECIFIC PERSPECTIVE

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Abstract

Introduction. The study aimed to compare anthropometric characteristics and selected components of physical fitness between physical education students from one university in Poland and one university in Romania, while also considering sex-related differences. **Material and methods.** The study involved 515 undergraduate students of physical education: 258 students from Poland (180 males, 78 females) and 257 students from Romania (170 males, 87 females). Body height, body mass, and body mass index (BMI) were measured. Selected components of physical fitness were assessed using three tests from the Eurofit battery: the Plate Tapping Test, the Sit-up Test, and the Standing Long Jump Test. Statistical analyses examined the effects of group and sex on anthropometric and physical performance outcomes. **Results.** Anthropometric differences between the examined Polish and Romanian university cohorts were generally small, although students from the Polish university demonstrated slightly higher body height, body mass, and BMI values. In contrast, clear differences were observed in selected components of physical fitness, depending on the type of test performed. Students from the Polish university achieved better results in muscular endurance and explosive power tests, whereas students from the Romanian university performed faster in upper-limb movement speed tasks. Significant sex effects were observed across all anthropometric and physical performance variables. **Conclusions.** The findings highlight the importance of considering biological sex and programme-specific context in the design and evaluation of physical education curricula. They also emphasize the need for multicenter longitudinal research incorporating detailed measurements of body composition, activity levels, and training load to better understand the mechanisms underlying differences in selected physical fitness components among physical education students.

Keywords: anthropometry, fitness, physical education students, Eurofit, sex differences

Introduction

Physical fitness and anthropometric characteristics are widely recognized as fundamental indicators of health, well-being, and athletic performance, particularly in young adult populations [1]. Physical education (PE) students represent a specific group whose training regimes, academic curricula, and lifestyle patterns are closely linked to the development of motor abilities and the maintenance of favorable anthropometric profiles [2, 3]. As future educators, coaches, and advocates of active living, PE students are expected not only to display above-average levels of physical fitness but also to serve as role models for the broader community. Research shows that societal and institutional expectations often require physical education teachers themselves to embody health and fitness, reinforcing their position as role models [4].

Anthropometric variables such as body height, body mass, and body mass index (BMI) are commonly used in research addressing both physical fitness and general health status [5, 6]. Among these, BMI remains one of the most frequently applied indices due to its ease of use and informativeness. However,

it has well-documented limitations: it does not distinguish between fat mass and non-fat body mass, which may lead to misclassification in physically active individuals with elevated muscle mass [7], nor does it provide information on fat distribution [8]. Despite these limitations, BMI, together with height and body mass, has been shown to co-vary with diverse components of physical fitness, including strength, speed, endurance, and agility [5, 6, 9].

A substantial body of research has demonstrated sex-related differences in both anthropometric traits and physical performance between groups of students from different countries. Men generally outperform women in strength- and power-oriented tasks, whereas women may hold advantages in selected domains, such as flexibility or balance-related tasks, depending on the test applied and the training context [10, 11]. Furthermore, cross-cultural comparisons suggest that environmental, lifestyle, and educational influences – including habitual physical activity, sport participation, and the intensity of PE curricula – may contribute to between-population variability in fitness outcomes [12]. Despite this, comprehensive comparative studies specifically targeting PE students in Europe remain scarce

[13, 14], which limits our understanding of how institutional and educational factors, together with sex-related influences, may affect anthropometric characteristics and selected physical fitness components within this professionally relevant cohort. Poland and Romania constitute an interesting area for comparison within the European system of physical education training, while also differing in recruitment procedures and study organization. At Babeş-Bolyai University in Cluj-Napoca, admission includes the assessment of candidates' motor abilities as the primary component of the qualification process, whereas at the Faculty of Physical Education and Health at the University of Białą Podlaska, recruitment is competitive and based primarily on secondary-school examination results. At the same time, the study programmes at both institutions have a practical and sport-oriented character and involve a comparable number of ECTS credits (180 ECTS in Romania and 184 ECTS in Poland). Comparing two institutions operating within different candidate-selection models, while maintaining broadly similar educational structures, may provide additional insight into differences in anthropometric characteristics and selected physical fitness components among physical education students [15, 16].

However, to date, no study has directly compared the anthropometric characteristics and physical fitness of physical education students from a Polish and a Romanian university while also examining sex differences and exploring how sex-related factors may influence observed outcomes. Therefore, this study aims to fill this gap by comparing height, body mass, BMI, and selected fitness measures (Plate Tapping Test, Sit-up Test, and Standing Long Jump Test) between students from the examined Polish and Romanian universities, while also considering sex-related differences within the examined cohorts.

Material and methods

Participants

Undergraduate students majoring in physical education were recruited from two institutions: the Faculty of Physical Education and Health at the University of Białą Podlaska (Poland) and the Faculty of Physical Education and Sport at Babeş-Bolyai University in Cluj-Napoca (Romania). The final sample comprised 258 Polish students (male: $n = 180$; female: $n = 78$) and 257 Romanian students (male: $n = 170$; female: $n = 87$). All participants were healthy, reported no history of chronic metabolic or cardiovascular disease, and provided written informed consent before testing. The study was conducted in accordance with the Declaration of Helsinki and approved by local ethics committees (Poland: SKE.0030.62.2025, June 27, 2025; Romania: 430/22.12.2022, December 22, 2022). Age was recorded as a descriptive variable but was not included as a covariate in the primary analyses.

Anthropometric measurements

Body height was measured to the nearest 0.1 cm using a portable stadiometer, and body mass to the nearest 0.1 kg using a calibrated electronic scale. All measurements were taken with participants barefoot and dressed in light clothing. Body mass index was calculated as body mass in kilograms divided by the square of height in meters (kg/m^2).

Physical fitness tests

Physical fitness was assessed using three standardized tests from the Eurofit Test Battery [17]:

- Plate Tapping Test (s) – assessing upper-limb speed and coordination. Participants alternately tapped two discs as quickly

as possible, and the total completion time was recorded in seconds.

- Sit-up Test (number of repetitions) – assessing trunk muscle endurance. Participants performed the maximum number of sit-ups within 30 seconds.
- Standing Long Jump Test (cm) – assessing lower-limb explosive power. Participants performed a two-foot horizontal jump from a standing position, and the longest distance achieved was recorded.

All tests were conducted under standardized laboratory conditions and supervised by experienced examiners to ensure protocol adherence. All participants were familiar with the Eurofit testing procedures due to their physical education training and previous practical coursework. The selected Eurofit tests were chosen because they represent distinct and complementary components of motor performance relevant to physical education students, including upper-limb movement speed and coordination (Plate Tapping Test), trunk muscle endurance (Sit-up Test), and lower-limb explosive power (Standing Long Jump Test). The selection was additionally determined by organizational feasibility and the need to ensure standardized testing conditions across both institutions.

Statistical analysis

All data were entered into a secure database and analyzed using Microsoft Excel 365 (version 16.x, Microsoft Corp., Redmond, WA, USA) and TIBCO Statistica 14.0.1 (TIBCO Software Inc., Palo Alto, CA, USA). Continuous variables are presented as mean $\pm$ standard deviation (SD). For each outcome variable (height, body mass, BMI, Plate Tapping Test, Sit-up Test, Standing Long Jump Test), the primary inferential approach was a two-way analysis of variance (ANOVA). The model included two fixed factors: group (Poland vs. Romania university cohorts) and sex, as well as their interaction term, to examine both main effects and potential sex-related variation in between-group differences. Assumptions of the ANOVA, including normality of residuals and homogeneity of variances, were verified before interpretation. When a statistically significant interaction between group and sex was identified ($\alpha = 0.05$), simple effects were examined by comparing the male and female subgroups separately between the two universities using independent-samples Welch t-tests (heteroscedasticity-robust, with Satterthwaite-adjusted degrees of freedom; Ruxton, 2006). Where appropriate, descriptive comparisons between male and female students within each study group were also reported. For multiple simple-effect tests within a single outcome, Bonferroni correction was applied. Tukey's HSD was not used, as it is not applicable to Welch contrasts. Effect sizes for simple pairwise comparisons were reported as Cohen's d with 95% confidence intervals [18]. All tests were two-tailed, with the significance threshold set at $\alpha = 0.05$.

Data management

All data entries were double-checked against original records. Outliers (values > 3 SD from the subgroup mean) were verified against raw data and excluded only when attributable to measurement or transcription error. Missing values for individual tests were handled by pairwise deletion at the outcome level. The dataset was anonymized before analysis, and all procedures adhered to institutional data-protection policies.

Data presentation and visualization

Results are presented in tables and figures. Tables include descriptive statistics (mean $\pm$ SD, n) and inferential outcomes,

including ANOVA effects and simple comparisons with mean differences, Cohen's *d*, test statistics, and *p*-values. Figures below illustrate mean values ($\pm$ SD) of selected anthropometric and physical fitness variables for visual comparison between groups. Subgroup sample sizes are indicated in table captions.

Results

The analysis indicated that male students from the Polish university were, on average, older, taller, and heavier than their Romanian peers, which was also associated with slightly higher values of body mass index. In terms of physical fitness, students from the Polish university demonstrated superior performance in the Sit-up Test and in the Standing Long Jump Test. In contrast, students from the Romanian university achieved better results in the Plate Tapping Test. Analysis of effect sizes showed that the magnitude of between-group differences was large for trunk muscle endurance (Sit-up Test), upper-limb movement speed (Plate Tapping Test), and age, moderate for lower-limb explosive power (Standing Long Jump Test), and small for the remaining anthropometric variables (Tab. 1, Fig. 1).

The analysis showed that female students from the Polish and Romanian universities were broadly comparable in their basic anthropometric characteristics, with only minor and non-significant differences observed. In contrast, marked disparities were evident in selected components of physical fitness between these two groups. Female students from the Polish university performed more repetitions in the Sit-up Test and achieved longer distances in the Standing Long Jump Test, whereas students from the Romanian university completed the Plate Tapping Test in shorter times (measured in seconds, where lower values indicate better performance). Effect-size estimates

indicated very large between-group differences for the Sit-up Test, large differences for the Standing Long Jump Test, and moderate differences for the Plate Tapping Test, while anthropometric effects remained minimal (Tab. 2, Fig. 2).

The two-way ANOVA revealed significant main effects of group across all analyzed outcomes (Tab. 3). Significant main effects of sex were also observed for all anthropometric and selected physical fitness characteristics, indicating that male students were taller, heavier, and outperformed female students in all fitness tests (all $p < .001$). Most interactions between group and sex were not statistically significant, indicating that between-group differences were generally consistent across sexes. A significant interaction between group and sex was observed only for the Plate Tapping Test ($p < .001$), indicating that sex modified the magnitude of between-group differences in upper-limb movement speed. Students from the Polish university achieved more Sit-up Test repetitions (male: $\Delta M = +6.13$; female: $\Delta M = +5.42$) and performed better in the Standing Long Jump Test (male: $\Delta M = +10.66$ cm; female: $\Delta M = +13.07$ cm). By contrast, in the Plate Tapping Test scored as completion time in seconds, where lower values indicate better performance, students from the Romanian university demonstrated better results in both sexes (male: $\Delta M = +1.57$ s, $p < .001$; female: $\Delta M = +0.70$ s, $p < .001$). Anthropometric differences between students from the two universities were generally small, whereas differences in selected components of physical fitness were more pronounced and largely consistent across sexes. Students from the Polish university outperformed their Romanian peers in Sit-up Test and Standing Long Jump Test performance, whereas students from the Romanian university showed better performance in the Plate Tapping Test (Tab. 3).

Table 1. Comparison of anthropometric characteristics and physical fitness test results between male students from the examined Polish ($n = 180$) and Romanian ($n = 170$) universities.

	Poland ($n = 180$)		Romania ($n = 170$)		ΔM	SE	<i>t</i>	df	<i>d</i>	<i>p</i>
	mean	SD	mean	SD						
Age (years)	22.17	1.01	20.97	1.40	1.20	0.13	9.15	306.92	0.99	< .001
Height (cm)	180.93	7.37	179.48	6.63	1.45	0.75	1.93	347.19	0.21	0.050
Mass (kg)	80.40	10.86	77.26	12.22	3.14	1.24	2.53	337.68	0.27	0.012
BMI (kg/m^2)	24.54	2.85	23.91	3.00	0.62	0.31	1.99	344.11	0.21	0.047
Plate Tapping Test (s)	10.04	1.20	8.48	0.93	1.57	0.11	13.74	335.29	1.46	< .001
Sit-up Test (n)	31.28	4.19	25.16	4.00	6.13	0.44	14.00	347.96	1.50	< .001
Standing Long Jump Test (cm)	242.02	21.22	231.36	21.91	10.66	2.31	4.62	345.27	0.49	< .001

ΔM = mean difference (PL-RO); SE = standard error; *t* = Welch's *t* statistic; df = degrees of freedom; *d* = Cohen's *d*. Positive ΔM indicates higher values in Poland. For Plate Tapping Test (s), lower values indicate better performance.

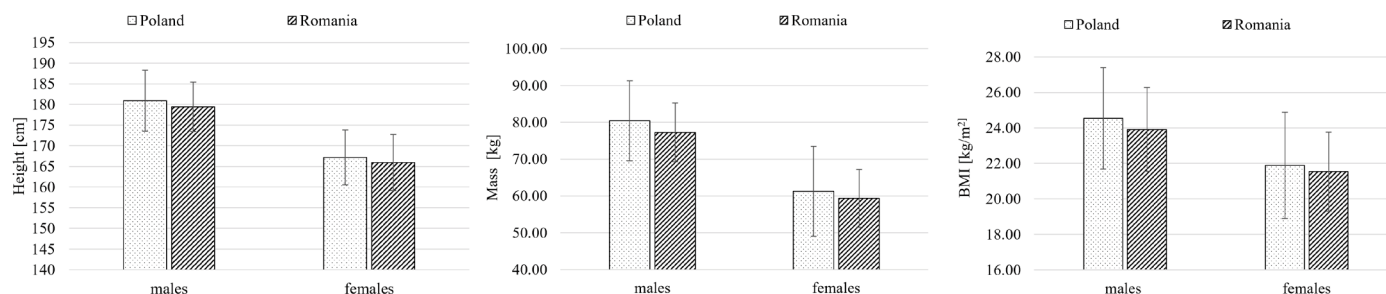
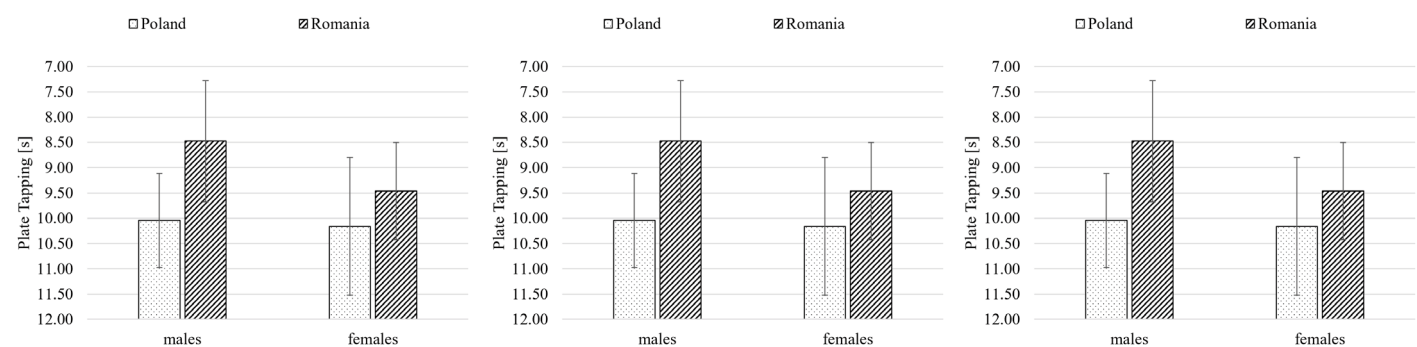


Fig. 1. Comparison of mean values ($\pm$ SD) of body height, body mass, and body mass index (BMI) in male and female physical education students from the examined Polish and Romanian universities.

Table 2. Comparison of anthropometric characteristics and physical fitness test results between female students from the examined Polish (n = 78) and Romanian (n = 87) universities.

	Poland (n = 78)		Romania (n = 87)		ΔM	SE	t	df	d	p
	mean	SD	mean	SD						
Age (years)	21.77	0.93	21.75	3.89	0.02	0.43	0.04	96.86	0.01	0.968
Height (cm)	167.17	5.98	165.93	6.78	1.24	0.99	1.24	162.96	0.19	0.217
Mass (kg)	61.27	7.96	59.39	7.85	1.88	1.23	1.52	160.54	0.24	0.131
BMI (kg/m ²)	21.89	2.36	21.54	2.23	0.35	0.36	0.97	158.64	0.15	0.334
Plate Tapping Test (s)	10.16	1.36	9.46	0.96	0.70	0.19	3.76	136.99	0.60	< .001
Sit-up Test (n)	27.10	3.46	21.68	3.89	5.42	0.57	9.49	162.99	1.47	< .001
Standing Long Jump Test (cm)	192.90	18.09	179.83	18.51	13.07	2.85	4.58	161.77	0.71	< .001

ΔM = mean difference (PL-RO); SE = standard error; t = Welch's t statistic; df = degrees of freedom; d = Cohen's d. Positive ΔM indicates higher values in Poland. For Plate Tapping Test (s), lower values indicate better performance.

**Fig. 2.** Comparison of mean values ($\pm$ SD) of Plate Tapping Test, Sit-up Test, and Standing Long Jump Test performance in male and female physical education students from the examined Polish and Romanian universities.**Table 3.** Two-way ANOVA (Group $\times$ Sex) for anthropometric and physical fitness outcomes in Polish and Romanian PE students.

Variable	Group effect	Sex effect	Interaction	PL vs RO (M)	PL vs RO (F)
Height (cm)	F = 5.24, p = 0.023	F = 446.69, p < .001	F = 0.03, p = 0.871	+1.45	+1.24
Mass (kg)	F = 8.68, p = 0.003	F = 345.83, p < .001	F = 0.40, p = 0.528	+3.14	+1.88
BMI (kg/m ²)	F = 4.92, p = 0.027	F = 93.82, p < .001	F = 0.29, p = 0.592	+0.62	+0.35
Plate Tapping Test (s)	F = 174.75, p < .001	F = 29.17, p < .001	F = 17.36, p < .001	+1.57 (p < 0.001)	+0.70 (p < 0.001)
Sit-up Test (n)	F = 284.02, p < .001	F = 103.73, p < .001	F = 0.87, p = 0.351	+6.13	+5.42
Standing Long Jump Test (cm)	F = 39.66, p < .001	F = 670.51, p < .001	F = 0.38, p = 0.536	+10.66	+13.07

The table reports F and p values for the main effects (Group, Sex) and their interaction, along with simple between-group mean differences (ΔM = Poland – Romania) within males and females where relevant. Cohen's d was reported for simple comparisons. Positive ΔM indicates higher values in Poland; for Plate Tapping Test (s), lower time denotes better performance. (Poland: males n = 180, females n = 78; Romania: males n = 170, females n = 87).

Discussion

The present study provided a direct comparison between Polish and Romanian physical education students, while also considering sex-related differences. Our findings are consistent with previous research showing that, overall, male students achieve higher performance outcomes than female students (p < .05). This aligns with existing literature indicating that

higher muscle mass and testosterone levels in males contribute to greater strength and endurance [19]. Anthropometric differences between the Polish and Romanian university cohorts were generally small, with more pronounced differences observed among male students. Among females, body size profiles were highly similar, with no significant between-group differences. Despite these similarities, a clear domain-specific

pattern emerged across selected components of physical fitness: both male and female students from the Polish university performed better in the Sit-up Test and the Standing Long Jump Test, whereas students from the Romanian university achieved better results in the Plate Tapping Test.

Analyses also confirmed a strong sex effect, with males outperforming females in most outcomes. Most between-group differences were generally consistent across sexes, although a significant interaction between group and sex was observed for the Plate Tapping Test. The observed pattern is consistent with the principle of training specificity and the typical structure of practical classes within physical education curricula. The superior performance of students from the Polish university in trunk muscle endurance and lower-limb explosive power tests may reflect differences in programme-specific training exposure. However, these variables were not directly assessed in the present study. Additionally, differences in exposure to plyometric or strength-endurance exercises may potentially be associated with the observed advantage in explosive power. Previous studies have shown that task-specific Sit-up Test training improves timed Sit-up Test performance [20], while plyometric programs yield moderate-to-large improvements in jump ability [21, 22].

Conversely, the students from the Romanian university demonstrated an advantage in the Plate Tapping Test – a Eurofit test assessing rapid alternating upper-limb movements – which may suggest the involvement of neural and coordination-related adaptations. This type of speed primarily relies on neuromuscular mechanisms, including rate coding, recruitment timing, and intermuscular coordination [23, 24]. Such adaptations may be associated with training effects and exposure to activities requiring rapid and precise cyclic movements, such as ball games or racket sports. This interpretation is consistent both with the design of the Plate Tapping Test within the Eurofit battery [17] and with previous studies highlighting the neural basis of coordination speed. However, because detailed data regarding curricular exposure and specific practical training content were not systematically collected in the present study, these interpretations should be considered tentative. It should be noted, however, that although the Plate Tapping Test demonstrates relatively lower test-retest reliability compared with other Eurofit items [25], systematic group-level differences may nevertheless emerge provided that familiarization procedures are standardized.

The modest anthropometric contrasts between students from the Polish and Romanian universities are plausible in a population of physical education students, who are typically characterized by health-oriented lifestyles and high exposure to structured sport practice. Such selection effects tend to homogenize somatic traits across institutions [15]. In Poland, admission fitness examinations may further reinforce this process by favoring applicants with specific physical profiles. BMI has well-known limitations, especially in athletic populations, where it may misclassify muscular students as overweight. Recent consensus highlights the importance of context-sensitive interpretation and, where feasible, the application of more precise body-composition assessment methods [26, 27]. Structural differences in the Polish secondary education system may explain the slightly higher average age of male students. Technical secondary schools last five years, whereas general secondary schools last four years, which may delay university entry among men, who more frequently choose technical education paths [28]. In Romania, by contrast, upper-secondary education typically lasts four years [29], making sex-specific age gaps less likely. Nonetheless, a similar pattern of differences in selected

physical fitness components was also observed among female students, for whom age did not differ between countries, suggesting that age alone is unlikely to account for the observed differences.

The strong sex-related effects in this study align with extensive literature showing robust male superiority in physical performance after puberty, driven by higher muscle mass, strength, and power capacity [30, 31]. Meta-analyses further indicate that sex differences are especially pronounced in upper-body strength, explosive force, and speed-power outcomes [32, 33, 34, 35]. Our findings confirm this well-established pattern, while also indicating that most between-group differences were generally consistent across sexes.

The strength-power profile observed among students from the Polish university is consistent with previous reports from Polish university cohorts, which highlighted strong performance in jump and strength-endurance tasks [15, 36]. Previous studies involving Romanian physical education students, on the other hand, have emphasized variability in fitness profiles depending on programme exposure and habitual activity [19, 37], which may partly correspond to the relative advantage in upper-limb movement speed observed in the present study. The novelty of this study lies in its direct, sex-stratified comparison between physical education students from two institutions operating within different educational and recruitment frameworks in Poland and Romania, using a harmonized protocol and balanced samples.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference. Second, the sample was drawn from only one university in Poland and one university in Romania, which limits the generalizability of the findings and makes it difficult to separate group-related effects from institution-specific influences. Third, no more precise body-composition assessment methods were included, and BMI alone is an imprecise indicator in athletic populations [26, 27]. Fourth, potentially relevant covariates such as training load, sport discipline, diet, or socioeconomic status were not assessed, nor were data on secondary education pathways collected, making interpretations of age structure contextual rather than causal. Fifth, although the Eurofit protocol for the Plate Tapping Test is standardized, its lower reliability compared to other items [25, 38] highlights the need for consistent familiarization. Finally, despite the use of effect sizes and adjustments for multiple comparisons, sampling and measurement error cannot be ruled out.

Future research should therefore adopt longitudinal and multi-center designs including multiple institutions and regions. Incorporating more precise body-composition assessment methods (e.g., DXA, BIA), collecting training logs (volume, intensity, discipline), and assessing lifestyle factors such as diet and sleep would enable a more precise analysis of underlying mechanisms. Expanding test batteries to include reaction time and coordination measures could provide a fuller picture of motor abilities [39]. In multi-site contexts, multilevel modelling is recommended to account for clustering within programmes and universities, while further analyses of BMI-fitness associations could be developed into separate, methodologically rigorous publications [18].

Conclusions

In summary, anthropometric differences between students from the Polish and Romanian universities were generally small, whereas domain-specific fitness disparities were consistent

across sexes. Students from the Polish university, both male and female, performed better in the Sit-up Test and the Standing Long Jump Test, while students from the Romanian university achieved shorter Plate Tapping Test times. These findings may reflect differences in programme-specific exposures and habitual sport participation rather than broad differences in overall physical performance. The results highlight the importance of sex-aware and programme-informed approaches to curriculum design and monitoring in physical education. They also underscore the value of reporting effect sizes and considering sex-related patterns in cross-national comparisons. Continued, methodologically enriched surveillance across multiple institutions will be crucial for informing educators, refining curricula, and evaluating student development with greater precision.

References

1. Wilczewski A., Chaliburda I., Kuśmierczyk P. (2025). Changes in body build and physical fitness of PE students in the years 1989–2004–2014–2024. *Polish Journal of Sport and Tourism* 32(1), 26–30. DOI: 10.2478/pjst-2025-0005
2. Dao C.T., Ha M.D. (2024). The effect of the sports club model on the physical fitness improvement of female students at Vietnam National University, Ho Chi Minh City. *Polish Journal of Sport and Tourism* 31(3), 28–34. DOI: 10.2478/pjst-2024-0019
3. Srisuk S. (2024). The impact of a targeted physical activity promotion program on physical fitness of undergraduate students at Nakhon Phanom University. *Polish Journal of Sport and Tourism* 31(3), 35–39. DOI: 10.2478/pjst-2024-0020
4. Barker D., Quennerstedt M., Johansson A., Korp P. (2021). Fit for the job? How corporeal expectations shape physical education teachers' understandings of content, pedagogy, and the purposes of physical education. *Physical Education and Sport Pedagogy* 28(1), 29–42. DOI: 10.1080/17408989.2021.1934664
5. Guo T., Zhang Y., Wang L. (2024). The relationship between BMI and physical fitness among university students. *Frontiers in Physiology* 15, 1435157. DOI: 10.3389/fphys.2024.1435157
6. Li Y., Shi N., Tao Y. (2025). Associations between body mass index and health-related physical fitness among Chinese university students: A cross-sectional study. *Frontiers in Sports and Active Living* 7, 1638381. DOI: 10.3389/fspor.2025.1638381
7. Milanese C., Itani L., Cavedon V., Saadeddine D., Raggi S. et al. (2025). Revising BMI cut-off points for overweight and obesity in male athletes: An analysis based on multivariable model-building. *Nutrients* 17(5), 908. DOI: 10.3390/nut17050908
8. Sweatt K., Garvey W.T., Martins C. (2024). Strengths and limitations of BMI in the diagnosis of obesity: What is the path forward? *Current Obesity Reports* 13(3), 584–595. DOI: 10.1007/s13679-024-00580-1
9. Sun F., He Q., Sun X., Wang J. (2022). The association between body mass index and muscular fitness in Chinese college freshmen. *International Journal of Environmental Research and Public Health* 19(21), 14060. DOI: 10.3390/ijerph192114060
10. Podstawski R., Boryśłowski K., Katona Z.B., Alföldi Z., Boraczyński M. et al. (2022). Sex differences in anthropometric and physiological profiles of Hungarian rowers of different ages. *International Journal of Environmental Research and Public Health* 19(13), 8115. DOI: 10.3390/ijerph19138115
11. Petri C., Campa F., Holway F., Pengue L., Arrones L.S. (2024). ISAK-based anthropometric standards for elite male and female soccer players. *Sports* 12(3), 69. DOI: 10.3390/sports12030069
12. Guo S., Izydorczyk B., Lipowska M., Kamionka A., Lizińczyk S. et al. (2023). Socio-cultural attitudes toward the body as a predictor of motivation for physical activity in young people brought up in Asian and European culture: Chinese-Polish comparison. *BMC Sports Science, Medicine & Rehabilitation* 15(1), 52. DOI: 10.1186/s13102-023-00662-y
13. Kyrychenko V., Deak G.F., Pop N.H., Gomboş L., Andrieieva O., Khrypko I. (2023). Comparative analysis of physical fitness of physical education major Romanian and Ukrainian students. *Studia Universitatis Babeş-Bolyai Educatio Artis Gymnasticae* 68(3), 5–19. DOI: 10.24193/subbeag.68(3).19
14. Kyrychenko V., Deak G.F., Pop N.H., Gomboş L. (2023a). Features of physical development and physical fitness of students from the Faculty of Physical Education and Sport, Babeş-Bolyai University. *Journal of Physical Education and Sport* 23(2), 510–516. DOI: 10.7752/jpes.2023.02063
15. Fugiel J., Kochan-Jacheć K., Koźlenia D., Domaradzki J. (2022). Changes in anthropometric measurements and physical fitness of Polish students in a 20-year period. *International Journal of Environmental Research and Public Health* 19(24), 16885. DOI: 10.3390/ijerph192416885
16. Radakovic R., Majkic B., Katanic B., Govindasamy K., Veljkovic A.A. et al. (2025). Differences in anthropometric characteristics and motor abilities of professional football players from leading and average teams in Serbian Super League. *BMC Sports Science, Medicine & Rehabilitation* 17(1), 111. DOI: 10.1186/s13102-025-01168-5
17. Council of Europe (1988). *Eurofit: Handbook for the Eurofit tests of physical fitness*. Strasbourg: Council of Europe, Committee for the Development of Sport.
18. Lakens D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology* 4, 863. DOI: 10.3389/fpsyg.2013.00863
19. Deak G.F., Kyrychenko V., Pop N.H., Khurtenko O., Zhovtenko Y., et al. (2025). Clustering undergraduate students enrolled in physical education majors in Romania and Ukraine based on their physical fitness levels. *Journal of Physical Education and Sport* 25(1), 167–174. DOI: 10.7752/jpes.2025.01019
20. Childs J.D., Teyhen D.S., Benedict T.M., Morris J.B., Fortenberry A.D. et al. (2009). Effects of sit-up training versus core stabilization exercises on sit-up performance. *Medicine & Science in Sports & Exercise* 41(11), 2072–2083. DOI: 10.1249/MSS.0b013e3181a84db2
21. Kons R.L., Orssatto L.B.R., Ache-Dias J., De Pauw K., Meeusen R. et al. (2023). Effects of plyometric training on physical performance: An umbrella review. *Sports Medicine – Open* 9, 4. DOI: 10.1186/s40798-022-00550-8
22. Ramirez-Campillo R., Sortwell A., Moran J., Afonso J., Clemente F.M. et al. (2023). Plyometric-jump training effects on physical fitness and sport-specific performance according to maturity: A systematic review with meta-analysis. *Sports Medicine – Open* 9(1), 23. DOI: 10.1186/s40798-023-00568-6
23. Gabriel D.A., Kamen G., Frost G. (2006). Neural adaptations to resistive exercise: Mechanisms and recommendations for training practices. *Sports Medicine* 36(2), 133–149. DOI: 10.2165/00007256-200636020-00004

24. Škarabot J., Ansdell P., Brownstein C.G., Howatson G. (2021). The knowns and unknowns of neural adaptations to resistance training. *European Journal of Applied Physiology* 121(3), 675-685. DOI: 10.1007/s00421-020-04567-3
25. Tsigilis N., Douda H., Tokmakidis S.P. (2002). Test-retest reliability of the Eurofit test battery administered to university students. *Perceptual and Motor Skills* 95(3), 1295-1300. DOI: 10.2466/pms.2002.95.3f.1295
26. Mathisen T.F., Ackland T., Burke L.M., Constantini N., Haudum J. et al. (2023). Best practice recommendations for body composition considerations in sport to reduce health and performance risks. *British Journal of Sports Medicine* 57(17), 1148-1158. DOI: 10.1136/bjsports-2023-106812
27. Wagner D.R., Heath E.M., Harper S.A., Cafferty E.A., Teramoto M. et al. (2024). Multicomponent body composition of university club sport athletes. *Journal of the International Society of Sports Nutrition* 22(1), 2446575. DOI: 10.1080/15502783.2024.2446575
28. NAWA/ENIC-NARIC Poland (2020). *Education system in Poland*. Polish National Agency for Academic Exchange. Warsaw.
29. CNRED (2023). *Education system in Romania*. Romania National Centre for Recognition and Equivalence of Diplomas. Retrieved 21 January, 2026 from: <https://cnred.edu.ro/en/education-system-in-romania/>
30. Hunter S.K. (2024). Sex differences in human performance. *The Journal of Physiology* 602(7), 1351-1371. DOI: 10.1113/JP284198
31. Hunter S.K., Angadi S.S., Bhargava A., Harper J., Hirschberg A.L. et al. (2023). The biological basis of sex differences in athletic performance: Consensus statement for the American College of Sports Medicine. *Translational Journal of the ACSM* 8(4), 1-33. DOI: 10.1249/TJX.0000000000000236
32. Nieto-Acevedo R., Romero-Moraleda B., Díaz-Lara F.J., de la Rubia A., González-García J. et al. (2023). A systematic review and meta-analysis of the differences in mean propulsive velocity between men and women in different exercises. *Sports* 11, 118. DOI: 10.3390/sports11060118
33. Nuzzo J.L. (2025). Sex differences in upper- and lower-limb muscle strength: Implications for performance testing. *European Journal of Sport Science* 25(5), 781-793. DOI: 10.1002/ejcs.12282
34. Bchini S., Ratel S., Souissi N., Vandewalle H., Sghaier D. (2023). Influence of muscle volume on jumping performance in adult males and females. *BMC Sports Science, Medicine and Rehabilitation* 15, 52. DOI: 10.1186/s13102-023-00639-x
35. Solli G.S., Sandbakk Ø., Tønnessen E. (2024). Sex differences in performance and their development across endurance sports: An updated review. *Sports Medicine – Open* 10, 82. DOI: 10.1186/s40798-024-00792-8
36. Podstawski R., Kosendiak A., Wilczyński K., Fecica L., Kulesza P. (2024). 30 years of change: Declining motor fitness and anthropometric characteristics among Polish university students, 1994–2024. *Life* 14(10), 1325. DOI: 10.3390/life14101325
37. Geantă V.A., Ardelean V.P., Dulceanu C., Bulzan C., Forț P.R. et al. (2025). Health-related physical fitness of Romanian university students: The European Fitness Badge approach. *Healthcare* 13, 1966. DOI: 10.3390/healthcare13161966
38. Koo T.K., Li M.Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine* 15(2), 155-163. DOI: 10.1016/j.jcm.2016.02.012
39. Tanineh W., Jones I., Nahhas R. (2023). Cardiorespiratory fitness, motor coordination, and health-related physical fitness among adolescents: Measurement properties and associations. *Global Pediatric Health* 10, 2333794X231207311. DOI: 10.1177/2333794X231207311

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