Original Article

Features of physical development and physical fitness of students from the Faculty of Physical Education and Sport, Babeş-Bolyai University

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Abstract.
Introduction: For physical education majors, a high level of physical fitness is the basis of professional and personal formation and development. Relevant information is necessary for further improvement of physical training programs. **Objective:** This study aimed at investigating the features of physical development and physical fitness of physical education majors, depending on their gender. **Methods:** In total, 161 students (107 males and 54 females) participated in this study, which was conducted in the Faculty of Physical Education and Sport, Babeş-Bolyai University. The following methods were used: anthropometry, a method of testing physical fitness indicators, and statistical analysis. **Results.** According to the results of clustering, based on the studied indicators, participants were divided into two clusters: Cluster 1 - 53 female and 2 male students, and the remaining in Cluster 2 - 105 male and 1 female student. Representatives of different clusters that were statistically significant (p<0.05) differed in all indicators, except in the modified sit-and-reach test, wall squat test right leg and wall squat test left leg. Cluster 1 received the conditional name "Students with reduced indicators" and Cluster 2 included "Students with increased indicators". Representatives of Cluster 2 had higher indicators of physical fitness compared to students of higher education institutions, but lower indicators than students of higher education institutions in physical education and sport departments. On the other hand, the physical development of the Cluster 2 participants was similar to the physical development of martial arts and boxing athletes. **Conclusion.** Depending on the test, indicators of physical fitness of students in Cluster 1 were rated as average and less than the average level of physical fitness for female students, and Cluster 2 showed average or above average levels for male students. The findings of this study could assist in improving the quality of education in physical education programs.
Keywords: university students, indicators, physical education, physical fitness.

Introduction

Physical fitness refers to the human ability to perform regular tasks with stamina and awareness, in the absence of excessive fatigue, and with enough energy to appreciate free-time activities and to manage unforeseen emergencies (Caspersen et al., 1985; Elshaer & Zayed, 2022). A high level of physical fitness gives university students the opportunity to successfully acquire theoretical knowledge and practical skills in the chosen specialty, to take an active part in public life, to adapt for everyday challenges, also allowing them to maintain work capacity, activity and mobility of young professionals (Antipova et al., 2020; Nesen & Klymenchenko, 2020).

Measurable components of physical fitness are classified under two groups: one related to health (cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility) and the other related to skills required for athletic performance (agility, balance, coordination, speed, power, and reaction time) (Caspersen et al., 1985). From a public health perspective, monitoring young people's physical fitness was, and still is, of the utmost importance (Bonilla et al., 2023; Boroş-Balint et al., 2015; Deak et al., 2014; Pribis et al., 2010; Sang & Wang, 2022), especially in the last couple of years, due to the COVID-19 pandemic (Barkley et al., 2021; Elshaer & Zayed, 2022; Hu et al., 2022). One of the main reasons for monitoring fitness levels in general population is the fact that physical fitness is a key indicator of health status with evidence suggesting a strong inverse mortality gradient for the highly fit (Nassif et al., 2012).

The data indicate a constant decline of physical fitness in university students over the last decades (Kaj et al., 2015; Pribis et al., 2010). Furthermore, an emerging issue seems to be the disharmony between body weight and height (Nesen & Klymenchenko, 2020; Pelech & Grygus, 2016; Sydorova & Horina, 2020). As a consequence, one can observe a reduction of the level of health, an increase in the number of students belonging to a special medical group etc. One of the main reasons of this problem is the low level of physical activity, while a

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second reason is the irresponsible attitude towards one's own health (Petritsa, 2018). Accordingly, experts note a tendency towards a decrease in physical fitness indicators in a significant proportion of higher education students (Nesen & Klymenchenko, 2020), which led to repeated revisions of physical training standards in the direction of lowering requirements in educational institutions of various types and the refusal to perform individual tests. Nowadays, experts reported low levels of physical fitness among Ukrainian students, ranging from 75.1% in the countryside, to 49.3% in the city of Kyiv (Sydorova & Horina, 2020). However, previous studies suggest that, with the implementation of specific exercise programs, some components of the health-related physical fitness might improve in undergraduate students (Deak & Boroş-Balint, 2017; Hlukhov et al., 2022; Pop et al., 2016).

A high level of physical fitness is a main priority for physical education majors. The physical fitness of a practitioner in physical education and sport is a guarantee of their competitiveness on the labor market and the basis of professional and personal formation and development. Therefore, this study aimed at investigating the features of physical development and physical fitness of physical education majors, depending on their gender. The results can be useful for improving the physical education major program in the upcoming semesters.

Methods
The present study was conducted during the months of May and June 2022, in Cluj-Napoca, Romania.
Participants
161 students from the Faculty of Physical Education and Sport, Babeş-Bolyai University, participated in this study (107 male students and 54 female students).

All participants were second year undergraduate students. At the beginning of the study, they were briefed on the testing procedure, and they gave permission for the results to be processed. The time of the tests and the testing procedure were the same for all participants. Participants had no contraindications regarding physical exercise.
Procedure
The following methods of measurements were used: anthropometric method and measurements of physical fitness (Three Minute Step Test, ml/kg/min; Modified sit-and-reach test, cm; Wall squat test (right and left legs) sec; Plate taping, sec; Sit up test, max reps 30 sec; Push-ups, max reps; Standing long jump test, cm).
Statistical Analysis
The assessment of physical development was carried out based on the calculation of the Body Mass Index (BMI, kg/m^2) (Hrynkiv et al., 2015). The data obtained during the research was subject to statistical processing, which was carried out using MS Excel, Statistica 10.0 and Data Mining technology.

At all stages of the experimental data, statistical processing significance level was defined as $\alpha=0.05$ ($p<0.05$), while p was presented as $p<0.05$ in cases when its value did not exceed $1.0 \cdot 10^{-5}$.
Cluster analysis
Based on the results of the cluster analysis, participants were divided into two clusters depending on gender. The cluster analysis was carried out using the Generalized EM module and the k-means cluster analysis, available in the Data Mining module of the Statistica 10.0 program, which has advanced pattern recognition capabilities, thus solving a wider range of clustering problems. At the same time, V-fold cross-validation was used to automate the process of setting the number of clusters. This module automatically implements ANOVA for continuous variables based on the use of Fisher's F-test.

During the frequency analysis, which was used to compare the proportions of students depending on gender, distributed by BMI, the χ^2 frequency test was applied.

The Shapiro-Wilk W-criteria, which has the highest power among alternative criteria, was used in order to evaluate the data's compliance with the normal distribution law. Note that if $p>0.05$ is reached, it is concluded that the analyzed distribution does not differ from the normal (Ghorbanzadeh et al., 2011).

In cases where the investigated indicators corresponded to the normal distribution law, the average $\bar{x}$ and the standard deviation S - ($\bar{x}$; S) were used to represent them, in others - the structural averages were used, namely the median Me as well as 25 and 75 percentiles - Me (25; 75).

For the comparative analysis of independent variables distributed according to the normal law, the parametric Student's t-criteria and previously the hypothesis of equality of variances according to Levene's test were used, and in other cases, its non-parametric counterpart, the Mann-Whitney U-test (Chakhvadze & Nikitchenko, 2017).

Results
According to the indicators of physical development and physical fitness, the present study showed that the students from the Faculty of Physical Education and Sport, Babeș-Bolyai University, can be divided into two clusters, depending on their gender. Since Cluster 1 included 53 female students and 2 male students, and Cluster 2 included 105 male students and 1 female student, Cluster 1 can be conditionally called "Students with reduced indicators of physical development and physical fitness", and Cluster 2 "Students with increased indicators of physical development and physical fitness". As can be seen in Fig. 1, according to the majority of indicators, the students included in Cluster 2 prevail over the representatives of Cluster 1.

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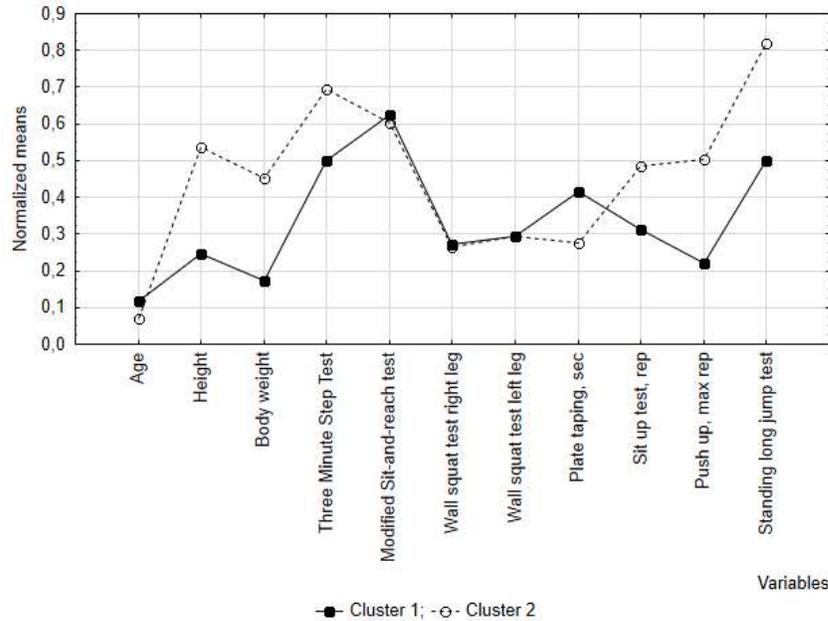

Fig. 1. Distribution of indicators of physical development and physical fitness of students depending on the cluster (n=161)

The results of the analysis of indicators of physical development and physical fitness of students from the Faculty of Physical Education and Sport, Babeș-Bolyai University, are presented in Table 1.

Table 1

Analysis of indicators of physical development and physical fitness of students from the Faculty of Physical Education and Sport, Babeș-Bolyai University (n=161)

№	Indicators	Clusters		Statistical indicators		p_1	p_2
		Cluster 1 (n=55)	Cluster 2 (n=106)	W_1	W_2		
	Weight and heights indicators						
1	Age	21 (20; 21)	21 (20; 21)	0.4836	0.8006	<0.05	<0.05
2	Height [cm]	(165.8; 6.5)	180 (174; 184)	0.2613	0.9531	0.2613*	0.0065
3	Body weight [kg]	(58.8; 7.5)	75 (68; 86)	0.9614	0.9408	0.0525*	0.0014
	Indicators of physical fitness						
1	Three Minute Step Test [ml/kg/min]	39 (36; 44)	56 (46; 61)	0.8178	0.9658	<0.05	0.0360
2	Modified sit-and-reach test [cm]	36 (28; 40)	(34.0; 8.1)	0.9410	0.9734	0.0094	0.1061*
3	Wall squat test right leg [sec]	37 (18; 59.2)	40 (27; 45)	0.9212	0.8296	0.0015	<0.05
4	Wall squat test left leg [sec]	33 (16; 56)	37 (30; 47)	0.9326	0.8980	0.0042	<0.05
5	Plate taping [sec]	(9.5; 1.0)	8.6 (7.8; 8.9)	0.9678	0.8841	0.1462*	<0.05
6	Sit up test [reps]	(21.2; 3.6)	(25.4; 4.0)	0.9772	0.9807	0.3791*	0.2909*
7	Push up [max reps]	16 (9; 22)	(36.6; 12.1)	0.9316	0.9868	0.0038	0.6144*
8	Standing long jump test [cm]	170 (148; 184)	(233.4; 21.5)	0.7143	0.9863	<0.05	0.5838*

Note: Me (25; 75) is the median, 25th and 75th percentiles; W1, W2 – Shapiro-Wilk test for Cluster 1 and Cluster 2, respectively; p – the level of significance reached; * - the studied indicators correspond to the normal law of distribution

As can be seen in Table 1, the comparative analysis of indicators excluding the sit up test required the use of non-parametric criteria, which was implemented using the Mann-Whitney U-test. According to the results, statistically significant (p<0.05) differences were found between the following indicators of students depending on the cluster: Body height, Body weight, Three-minute step test, Plate tapping test, Sit up test, Push-ups and Standing long jump test.
On the other hand, there were no statistically significant differences (p>0.05), depending on the cluster, regarding the Modified Sit-and-reach test and Wall squat test (Table 2).

Table 2

Calculation table of comparative analysis of indicators of physical development and physical fitness of students from the Faculty of Physical Education and Sport, Babeș-Bolyai University (n=161)

№	Indicators	Statistical indicators				p
		$\sum_1$	$\sum_2$	U	Z	
1	Age	8555.5	4485.5	2884.5	-0.1069	0.9148
2	Height [cm]	11082.5	1958.5	418.5	8.8970	<0.05
3	Body weight [kg]	11041	2000	460	8.7491	<0.05
4	Three Minute Step Test [ml/kg/min]	10756.5	2284.5	744.5	7.7350	<0.05
5	Modified sit-and-reach test [cm]	8216	4825	2545	-1.3171	0.1878
6	Wall squat test right leg [sec]	8744	4297	2757	0.5614	0.5745
7	Wall squat test left leg [sec]	8855.5	4185.5	2645.5	0.9589	0.3376
8	Plate taping [sec]	6941.5	6099.5	1270.5	-5.8600	<0.05
9	Sit up test [reps]	10207	2834	1294	5.7763	<0.05
10	Push up [max reps]	10857	2184	644	8.0932	<0.05
11	Standing long jump test [cm]	11327	1714	174	9.7685	<0.05

Note: $\sum_1$, $\sum_2$ – the sum of the ranks of indicators of Clusters 1 and 2, respectively; U – Mann-Whitney test; Z is a statistic used for samples larger than 20; p is the level of significance reached

At the same time, the analysis of the results of the Sit up test showed the homogeneity of variances in the samples (F-statistics of Levene's test was 0.3727 at p=0.5424), which made it possible to confirm the results obtained by the Mann-Whitney test using the Student's t-test (t=5.5129; p<0.05).

It was determined that the indicators of physical fitness of the students of Cluster 1, depending on the test, corresponded to below average or average level of physical fitness for female students, and Cluster 2 - to average or above average level for male students.

Not all BMI indicators of the participants, depending on the cluster, obeyed the normal distribution law: for the representatives of Cluster 1, the Shapiro-Wilk W-criterion was 0.9778 (p=0.3968), and for Cluster 2 – 0.9667 (p= 0.0405). The median BMI of students with higher indicators of physical development and physical fitness exceeded this indicator for female students by 10.6%: 23.5 (21.8; 25.5) versus 21.1 (19.5; 23.0) kg/m^2. Moreover, the identified differences were statistically significant (U=1406; Z=5.3771; p<0.05).

Discussion

The issues associated with determining the characteristics of physical development and physical fitness of different socioeconomic groups and their dynamics due to different kinds of physical activities remain one of the most valued research topics (Hafsteinsson Östenberg et al., 2022; Pan et al., 2022). Undergraduate students represent one of the abovementioned groups of interest for the scientific community (Degtyarenko et al., 2022). Particular attention was given to the physical development and physical fitness assessment of physical education majors (Gres & Ostroglyad, 2020; Kashuba et al., 2019; Kashuba et al., 2020). Published studies show that, despite the growing requirements for the physical fitness of modern students, they have a low level of physical fitness (Antipova et al., 2020; Nesen & Klymenchenko, 2020; Tamozhanska et al., 2018). In this context, the aim of the present study was to assess the physical development and physical fitness levels of physical education majors from the Babeș-Bolyai University. Therefore, the assumptions made were that, according to the studied indicators, students would be divided by gender, and that the physical development and physical fitness of the participants would exceed similar indicators of the general sample of students.

Results showed that students from the Faculty of Physical Education and Sport, Babeș-Bolyai University, were not clearly divided by gender, but according to the level of their physical fitness. Apparently, one female student had the level of physical fitness more typical for the mainly male cluster (Cluster 2). On the other hand, there were two male students who had a level of physical fitness more typical for the mainly female cluster (Cluster 1). Cluster 1 included students with lower score, as compared to Cluster 2. Representatives of different clusters differed statistically significantly (p<0.05) in terms of physical development, as well as in terms of physical fitness, with the exception of the modified sit-and-reach test and squatting near the wall while standing on the right and left leg.

The distribution of students from the Faculty of Physical Education and Sport, Babeș-Bolyai University, according to the BMI indicator depending on gender, showed that some students had what it is considered a normal BMI (18.5-24.9 kg/m^2). Among students with reduced indicators of physical development, 9.3% did not fall within the healthy weight range or normal range, and among students with increased indicators, 34.6% did not fall within the normal range. It was determined that among the representatives of Cluster 1, the part of students with a normal ratio of mass and body length statistically significantly outweighs the part of such students of

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Cluster 2 ($\chi 2$=11.933; p=0.0006). However, analyzing the results regarding the physical development, attention was paid to the fact that scientists recommend treating athletes' BMI with caution, and using the indicator only for a rough estimate. They emphasize that the BMI of athletes can exceed the average statistics due to developed muscles. Indeed, familiarization with the results of specialists showed that, depending on the sport, the average indicators of BMI of athletes exceeded what is considered to be normal or healthy weight range (Chakhvadze & Nikitchenko, 2017; Hrynkiv et al., 2015; Majevska et al., 2014). The BMI data characteristic for students with elevated indicators were correlated with the indicators obtained by other scientists who assessed athletes engaged in martial arts (21.6-23.5 kg/m^2), and boxing (23.6 kg/m^2) (Chakhvadze & Nikitchenko, 2017; Ghorbanzadeh et al., 2011; Kashuba et al., 2019; Katić et al., 2005). Several sources reported a low level of physical fitness (62.9%-66.4%) in students (Nesen & Klymenchenko, 2020; Petritsa, 2018).

The data presented in the scientific literature regarding the results of students' performance of physical fitness tests showed that the average indicators of students equal to the average indicators of representatives of Cluster 1, and the results shown by students of Cluster 2 were in some cases significantly higher. For example, according to the data from Petritsa (2018), for the Standing long jump test, the average score of students was (173.36; 16.71) cm. Similarly, according to the data from Nesen and Klymenchenko (2020), for female students the result was (159.84; 20.70) cm, and for male students the result was (218.08; 23.47) cm. In both cases, the authors found low speed and strength development levels. For this study, the students of Cluster 1, with an average indicator of 170 (148, 184) cm, were characterized by speed and strength levels lower than average, and the average value of the indicator among students of Cluster 2 was (233.4, 21.5) cm, which falls within the average development levels of speed and strength.

On the other hand, the results of this study were statistically significantly lower than the average level of students from ski departments (t=3.1652; df=106+9-2; tkr=1.6585; p<0, 05) and of students from Eastern martial arts departments (t=8.4555; df=106+17-2; tkr=1.6575; p<0.05), which were (246.0; 10.61) and (253.2; 4.58) cm, respectively (Sydorova & Horina, 2020).

According to Pelech and Grygus (2016), average results of the maximal push-up test in the case of female students were (6.76; 0.15) reps, and in the case of male students were (27.44; 0.55) reps, where the average indicators were presented by the authors as ($\bar{x}$; m), m being the sampling error. The results of this study suggest that the average indicators of students of Cluster 1, which were 16 (9; 22), exceeded the indicators of female students, and the average indicators of students of Cluster 2, which were (36.6; 12.1) times, significantly exceeded the data found in the literature. Compared to the results of Pelech and Grygus (2016), the results obtained from analyzing Cluster 2 data were statistically significantly higher (t=7.0593; df=106+55-2; tkr=1.6545; p<0.05). However, the level of strength of the participants of this research, regardless of the cluster, was found to be average.

Conclusions

Despite the increased requirements of the physical fitness of higher education students, requirements which make possible to effectively carry out educational activities, at the present moment, a decreasing trend in physical fitness levels of undergraduate students can be observed. It is a well-known fact that, for physical education majors, a high level of physical fitness is of primary importance, as it allows them to be competitive on the labor market and as it is the basis of professional and personal formation and development. Issues related to the assessment of physical development and physical fitness of higher education students and athletes, depending on specialization, are widely discussed by specialists, while the peculiarities of physical development and physical fitness of physical education majors are not sufficiently covered in the scientific literature.

According to the results of clustering, the students from the Faculty of Physical Education and Sport, Babeş-Bolyai University, were not clearly divided by gender. Based on the studied indicators, Cluster 1 included 34.2% of the examined students: 53 females and 2 males, and the remaining of 65.8%, i.e. 105 male students and 1 female student, made up Cluster 2. Representatives of the different clusters were statistically significant (p <0.05) in almost all indicators. The Modified sit-and-reach test and the Wall squat test were the exceptions. Thus, Cluster 1 received the conditional name "Students with reduced indicators" and Cluster 2 was named "Students with increased indicators".

The present study proved that the average indicators of the representatives of Cluster 1 exceeded the average indicators of female students found in the scientific literature. The physical development of the participants of Cluster 2 turned out to be similar to the physical development of athletes engaged in martial arts and boxing. In general, the indicators of the physical fitness of students of Cluster 1 corresponded to below average or average levels of physical fitness, while Cluster 2 corresponded to average or above average levels, depending on the test. At the same time, the representatives of Cluster 2 had higher indicators of physical fitness as compared to the indicators of higher education students found in the scientific literature.

Nevertheless, the indicators were lower when compared to data found in the scientific literature for physical education majors.

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