



# Relationships between socioeconomic factors versus the anthropometric and motor characteristics of Polish female university students (2000–2018)

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## Abstract

**Aim:** The aim of this study was to determine the relationships between socioeconomic factors (SES), anthropometric characteristics and motor abilities of female university students. **Materials and Methods:** The study was conducted in 2000-2018 on 3955 female university students aged  $19.72 \pm 0.75$  years who were randomly selected from the population of students attending obligatory physical education (PE) classes. The participants' body mass and height were measured, and the students participated in 13 motor ability tests that assessed their speed/agility, flexibility, strength, endurance-strength, and endurance abilities. Multiple independent samples were compared using the Kruskal-Wallis test or the mean-ranks post-hoc test when significant differences were observed in the participants' motor abilities. **Results:** Statistically significant differences in the participants' body mass, body height, BMI and motor abilities (speed/agility, flexibility – partly, strength, and strength-endurance) were associated with differences in the students' SES. Greater mean differences in SES were associated with differences in the anthropometric and motor characteristics of students. Environmental factors such as the place of permanent residence, monthly budgets, mother's and father's educational background were least likely to be associated with female students' endurance abilities. **Conclusions:** Female students who had higher monthly budgets, resided in large cities, and had better educated parents were generally taller and had a higher level of motor abilities. An inverse relationship was noted between motor abilities vs. body mass and BMI.

**Keywords:** motor performance, somatic traits, socioeconomic indicators, female university students

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## INTRODUCTION

The transition from secondary school to university marks a critical point when various health-related habits are formed. Young people enter a new stage of life and have to face numerous physical, physiological and mental requirements. This transitional period also involves social formation when a young person switches from infantile dependency to an adult, chooses and masters a profession, finds a partner and starts a family.

The first year of university marks the attainment of physical maturity [1] which is critical for growth and development [2]. Research studies focusing on first-year university students investigate the transition from the last stage of adolescence to maturity and the potential health implications in adulthood. University years generally mark the beginning of reproductive life; therefore, the health of university students has significant implications for the health of the future generations [3]. In particular, the formation and establishment of healthy habits in the juvenile period contributes to a healthy lifestyle in adulthood and affects the health of both youngsters and adults [4,5]. The health status of university students will also influence the performance of future experts on the labor market.

Research has demonstrated that long-term sedentary behavior is harmful to health and that regular exercise is essential for healthy somatic and motor development [6]. Despite the above, many female university students develop undesirable habits by refraining from physical activity (PA) and adopting a sedentary lifestyle [7]. These negative phenomena were also observed among female students in Polish universities [8], and they are responsible for a decline in motor abilities [1,9] and a continued increase in body mass and BMI among young women enrolled in college, observed worldwide [10,11]. A recent meta-analysis revealed that first-year university students gain approximately 4 lbs (1.81 kg) during a period of 3 to 12 months [12]. In most cases, excess weight contributes to an increase in fat mass [13], and first-year students tend to maintain the gained weight [14] or even continue to gain weight in successive years of college [15].

Academic youths are an important social group that deserves to be thoroughly researched. Very few studies dedicated to the motor and somatic development of female university students can be found in recent literature [16]. Most research had been conducted between the 1950s and the 1990s [9,17], and it focused mainly on the stature and body mass of male students [18]. Studies investigating the influence of socioeconomic factors on first-year university students' anthropometric and motor characteristics are even more scarce. This is a reason for concern, especially that selected indicators of somatic and motor development play an important role as points of reference in health evaluations [19].

In view of the above, the aim of this study was to evaluate the relationships between the anthropometric characteristics and motor abilities of female university students and selected socioeconomic factors, including the place of permanent residence, monthly budget, and mother's and father's educational background.

## MATERIALS AND METHODS

### *Participants*

The study was conducted in 2000-2018 on 3955 full-time, first-year female university students (2000 - 667, 2002 - 351, 2004 - 471, 2006 - 313, 2008 - 501, 2010 - 390, 2012 - 321, 2014 - 292, 2016 - 335, 2018 - 314) aged 19÷25 ( $19.72 \pm 0.75$  years) who were randomly selected from the population of students attending obligatory physical education (PE) classes at the University of Warmia and Mazury (UWM) in Olsztyn, Poland. Beginning from 2000, the study was carried out at two-year intervals during the summer semester (April/May). Students were selected randomly on a volunteer basis, and those who wished to participate signed an informed consent form. If the chosen student did not wish to participate in the study, another potential candidate was randomly drawn. Only students who were absent, for whatever reason, on the day the tests and measurements were performed, were excluded from the study. The participants were selected from among volunteers who did not take any medication or nutritional supplements, were in good health, had no history of blood diseases or diseases affecting biochemical and biomechanical factors.

### *Ethics*

The research was carried out upon the prior consent of the Ethical Committee of the UWM in Olsztyn (No. 39/2011). The study involved male student volunteers who signed a written statement of informed consent.

### *Instruments and procedures*

Body mass (to the nearest 0.1 kg) and body height (to the nearest 1 mm) were measured using a calibrated medical scale with a stadiometer (WB-150 ZPU Tryb Wag, Poland), and the results were used to calculate the participants' BMI. Student volunteers participated in thirteen motor ability tests assessing their *speed/agility abilities*: 4×10 m shuttle run [s], 8-s skipping with hand clapping (SHC) test [number of claps], zig-zag run [s]; *flexibility abilities*: standing forward bend [cm], barbell overhead trunk rotation [cm]; *strength abilities*: standing broad jump [cm], sit-ups in 30 s [number of sit-ups], medicine ball (4 kg) forward throw [cm], medicine ball (4 kg) backward throw [cm], flexed arm hang on bar [s]; *endurance-strength abilities*: 1-minute and 3-minute Burpee tests (1-MBT, 3-MBT) [number of cycles]; and *endurance abilities*: 12-minute Cooper test on a rowing ergometer [m]. The reliability of the repeated motor tests was regarded as high (ICC - intraclass correlation coefficient: 0.82–0.91, CV - coefficient of variation: 1.4–3.3%). These motor tests had been widely used to analyze the motor abilities of different age groups, including as separate trials to assess specific motor abilities and as part of batteries of tests to evaluate general motor fitness [20,21]. The validity and reliability of the applied tests had been confirmed by other researchers [22,23]. In each group, motor ability tests were conducted in the same order, beginning from strength, speed, agility, endurance- strength, and endurance tests, and ending in flexibility tests. The instructions for each test were given during the PE class, and students were allowed sufficient time to practice. The participants performed the same standard active warm-up exercises for 10 minutes before each test [24].

The participants provided information about their gender, age, parents' educational background, place of permanent residence, and monthly budget by filling out a questionnaire. The results of the questionnaire were used to evaluate the impact of selected environmental factors on the students' performance in motor ability tests.

### *Statistical analysis*

The results were processed with the use of descriptive statistics (mean, standard deviation, etc.) in Statistica PL v. 13 at a significance level of  $\alpha = 0.05$ . The assumptions of the parametric test were not met because data did not have normal distribution, the studied groups had unequal size, and sample variances were not homogeneous. Therefore, the Kruskal-Wallis test for comparing more than two independent samples was used as the non-parametric equivalent of one-way ANOVA. The mean-rank post-hoc test for multiple comparisons was used when significant differences were observed in the participants' motor abilities.

### *Statement*

The present study is a part of an 18-year research project (2000-2018) involving Polish first-year university students (females and males). The results noted in female university students complement the observations of the anthropometric and motor characteristics of Polish university students of both sexes. Therefore, the research methodology, the presentation of results and the cited references are highly similar to those presented in previous articles by the authors, addressing the same research topic. The authors assume full responsibility for the content and structure of this manuscript.

## RESULTS

The socioeconomic characteristics of the tested subjects are presented in Table 1. The correlations between anthropometric characteristics vs. the place of permanent residence, the students' monthly budgets, and mother's and father's educational backgrounds are presented in Table 2, and the relationships between motor abilities and the analyzed environmental factors are presented in Tables 3-4.

### *Socioeconomic characteristics of the studied population (Analysis 1)*

The largest group of the surveyed students (37.8%) resided permanently in cities with a population higher than 50,000 (P3). Residents of rural areas and cities with a population below 50,000 were less well represented (P3 -33.2% and P2 - 29.0%). More than half of female students (R1 - 52.9%) had monthly budgets below PLN 1500. More than a third of the studied subjects (R2 - 33.7%) had monthly budgets of PLN 1500-3000, whereas the smallest percentage of the participants (R3 - 13.4%) had more than PLN 3000 at their disposal on a monthly basis. Most of the surveyed subjects had mothers and fathers with secondary education (M2 - 43.7% and F2 - 50.3%). Nearly 40% of the participants (38.2%) had mothers with university education, whereas the percentage of female students whose fathers were university graduates was much smaller (23.1%). The proportion of students whose fathers had primary school education (26.6%) exceeded the percentage of students raised by mothers with primary school education (18.1%) (Table 1).

### *Socioeconomic vs. anthropometric characteristics (Analysis 2)*

Students who resided in cities with a population higher than 50,000 (P3) and had monthly budgets in excess of PLN 3000 (R3) were characterized by significantly lower ( $p<0.001$ ) body mass than their peers who inhabited rural areas (P1) and cities with a population below 50,000 (P2) and had monthly budgets below PLN 3000 (R1 and R2). The lowest body mass was also noted in students raised by mothers and fathers with university education (M3 and F3), but significant differences were observed only between students whose mothers had university and primary school education (M1 > M3). Students who resided in cities with a population higher than 50,000 (M3), had monthly budgets in excess of PLN 3000, and were raised by mothers (only M3>M1) and fathers with university education were significantly ( $p<0.001$ ) taller than their peers. The residents of cities with a population higher than 50,000 (P3) whose monthly budgets exceeded PLN 3000 (R3) and whose mothers and fathers were university graduates (M3 and F3) were also characterized by significantly lower BMI ( $p<0.001$ ) (Table 2).

Table 1. Socioeconomic characteristics of the female university students

Characteristics	Categories	Group	N	%
Place of permanent residence	Rural area	P1	1312	33.2
	City < 50,000	P2	1148	29.0
	City > 50,000	P3	1495	37.8
Monthly budget	< PLN 1500	R1	2091	52.9
	PLN 1501 to 3000	R2	1332	33.7
	> PLN 3000	R3	532	13.4
Mother's educational background	Primary/Vocational	M1	718	18.1
	Secondary	M2	1727	43.7
	University	M3	1510	38.2
Father's educational background	Primary/Vocational Secondary University	F1	1051	26.6
		F2	1991	50.3
		F3	913	23.1

N - number of respondents; P1 - rural area, P2 - city < 50,000, P3 - city > 50,000, R1 - < PLN 1500, R2 - from PLN 1501 to 3000, R3 - > PLN 3000; M1÷M3 - primary school/vocational school, M2 - secondary school, M3 - university, F1÷F3 - Father's educational background (identical criteria as in mother's educational background).

Table 2. Place of residence, monthly budget, mother's and father's educational background vs. anthropometric characteristics

Indicators		Place of residence				Monthly budget					
		Group	Mean ± SD	N	p	D	Group	Mean ± SD	N	p	D
Anthropometric characteristics	Body mass [kg]	P1	59.8 ±8.20	1312	<0.001	P3<P1, P2	R1	59.4 ±8.02	2091	0.001	R3<R1, R2
		P2	59.3 ±8.05	1148			R2	59.2 ±7.48	1332		
		P3	58.4 ±7.14	1495			R3	57.8 ±7.65	532		
	Body height [cm]	P1	164.3 ±6.52	1312	<0.001	P3>P1, P2	R1	164.4 ±6.28	2091	<0.001	R3>R1, R2
		P2	164.9 ±6.67	1148			R2	164.8±6.60	1332		
		P3	165.8 ±6.18	1495			R3	165.5±6.81	532		
	BMI [kg/m <sup>2</sup> ]	P1	22.2 ±3.47	1312	<0.001	P3<P1, P2	R1	22.0 ±3.14	2091	<0.001	R3<R1, R2
		P2	21.9 ±3.18	1148			R2	21.9 ±3.18	1332		
		P3	21.3 ±2.75	1495			R3	21.2 ±3.25	532		
	Mother's educational background						Father's educational background				
	Body mass [kg]	M1	59.9 ±7.45	718	<0.001	M1>M3	F1	59.4 ±7.85	1051	0.155	-
		M2	59.1 ±7.66	1727			F2	59.2 ±7.89	1991		
M3		58.7 ±8.08	1510	F3			58.5 ±7.46	913			
Body height [cm]	M1	164.8 ±6.53	718	0.011	M3>M2	F1	165.0 ±6.05	1051	<0.001	F3>F1, F2	
	M2	164.8±6.6	1727			F2	165.1 ±6.58	1991			
	M3	165.4±6.2	1510			F3	166.2 ±6.66	913			
BMI [kg/m <sup>2</sup> ]	M1	22.1 ±3.23	718	<0.001	M3<M1, M2	F1	21.9 ±3.05	1051	0.001	F3<F1, F2	
	M2	21.8 ±3.17	1727			F2	21.8 ±3.23	1991			
	M3	21.5 ±3.08	1510			F3	21.3 ±3.02	913			

SD – standard deviation; N - number of respondents; p - statistical significance; D - significant differences; P1 – rural area, P2 - city < 50,000, P3 – city > 50,000, R1 - < PLN 1500, R2 – from PLN 1501 to 3000, R3 - > PLN 3000; M1 – primary school/vocational school, M2 – secondary school, M3 – university, F1÷F3 - Father's educational background (identical criteria as in mother's educational background).

#### Place of permanent residence vs. motor abilities (Analysis 3)

The place of permanent residence had no significant ( $p>0.05$ ) influence on the scores in the 8-s SHC, downward bend, barbell overhead trunk rotation, and 12-min rowing ergometer tests. The residents of cities with a population below and above 50,000 (P2, P3) performed significantly better ( $p<0.05$ ) in the standing broad jump, 30-s sit-ups, medicine ball forward throw and the 3-MBT. In addition, students inhabiting cities with a population above 50,000 (P3) performed significantly better ( $p<0.05$ ) in the 4×10 m shuttle run, zig-zag run, medicine ball backward throw, flexed arm hang on a bar, and 1-MBT than those who resided in rural areas and cities with a population below 50,000 (P1, P2) (Table 3).

#### Students' monthly budget vs. motor abilities (Analysis 4)

Students with monthly budgets higher than PLN 1500 (R2, R3) scored significantly ( $p<0.05$ ) higher in the 8-s SHC, 4×10 m shuttle run, zig-zag run, barbell overhead trunk rotation, standing broad jump, and 3-MBT than those with a monthly budget below PLN 1500 (R1). Students with monthly budgets in excess of PLN 3000 (R3) significantly outperformed the participants with smaller budgets (R1, R2) in the downward bend, 30-s sit-ups (only R1<R3), medicine ball forward throw (only R1<R3), flexed arm hang on a bar (only R1<R3) and 1-MBT (only R1<R3), whereas no significant differences between these groups were noted in the medicine ball backward throw and the 12-min rowing ergometer test (Table 3).

#### Mother's educational background vs. motor abilities (Analysis 5)

Students raised by better educated mothers scored higher in the 8-s SHC, 30-s sit-ups, and medicine ball forward throw (in the remaining tests: M3>M2, M1), 4×10 m shuttle run (only), downward bend, barbell overhead trunk rotation (in the remaining tests: M1> M2, M3), and medicine ball backward throw (only between M3>M1) (Table 4).

## Father's educational background vs. motor abilities (Analysis 6)

Students raised by better educated fathers also scored higher in the 8-s SHC, 30-s sit-ups, medicine ball backward and forward throws (in the remaining tests: F3>F1, F2), and barbell overhead trunk rotation (F3<F1, F2). The father's educational background was also correlated with the scores in the 1- and 3-MBT (F3>F2), and the 12-min rowing ergometer test (F3>F1) (Table 4)

Table 3. Place of residence and students' monthly budget vs. motor indicators

Indicators		Place of residence					Monthly budget				
		Group	Mean ± SD	N	p	D	Group	Mean ± SD	N	p	D
Speed/agility	8-s SHC [number of claps]	P1	24.7 ±4.06	1312	0.337	-	R1	24.4 ±3.63	2091	<0.001	R1<R2, R3
		P2	25.1 ±3.77	1495			R2	25.5 ±3.74	1332		
		P3	24.9 ±3.64	1148			R3	25.6 ±3.91	532		
	4x10 m shuttle run* [s]	P1	12.7 ±1.15	1312	0.019	P1>P3	R1	13.1 ±1.16	2091	<0.001	R1>R2, R3
		P2	12,7 ±1.10	1495			R2	12.2 ±1.17	1332		
		P3	12,6 ±1.07	1148			R3	12.2 ±0.98	532		
	Zig-zag run* [s]	P1	29.9 ±2.65	1001	<0.001	P3<P1, P2	R1	29.8 ±2.39	1467	<0.001	R1>R2, R3
		P2	29.6 ±2.45	998			R2	29.4 ±2.54	995		
		P3	29.2 ±2.31	880			R3	29.3 ±2.68	417		
Flexibility	Downward bend [cm]	P1	8.0 ±6.11	1312	0.261	-	R1	7.3 ±6.43	2091	0.001	R3>R1, R2
		P2	8.2 ±6.45	1495			R2	7.8 ±6.20	1332		
		P3	7.8 ±6.33	1148			R3	8.3 ±6.02	532		
	Barbell* overhead trunk rotation [cm]	P1	68.8 ±5.54	1001	0.449	-	R1	69.6 ±5.83	1467	<0.001	R1>R2, R3
		P2	68.8 ±5.79	998			R2	67.8 ±5.89	995		
		P3	68.5 ±6.16	880			R3	67.8 ±5.53	417		
Strength	Standing broad jump [cm]	P1	159.4 ±18.97	1312	<0.001	P1<P2, P3	R1	160.2 ±18.96	2091	<0.001	R1<R2, R3
		P2	162.3 ±19.65	1495			R2	162.6 ±19.16	1332		
		P3	162.4 ±18.75	1148			R3	162.8 ±20.38	532		
	30-s sit-ups [number of sit- ups]	P1	18.6 ±4.55	1312	<0.001	P1<P2, P3	R1	18.8 ±4.45	2091	0.002	R1<R3
		P2	19.5 ±4.46	1495			R2	19.1 ±4.48	1332		
		P3	19.6 ±4.34	1148			R3	19.4 ±4.49	532		
	Medicine ball backward throw [cm]	P1	635.5 ±150.63	1312	0.024	P1<P3	R1	642.2 ±151.77	2091	0.558	-
		P2	647.6 ±155.40	1495			R2	646.9 ±154.13	1332		
		P3	652.0 ±153.75	1148			R3	649.9 ±158.59	532		
	Medicine ball forward throw [cm]	P1	528.0 ±120.26	1001	0.012	P1<P2, P3-	R1	528.0 ±118.79	1467	0.014	R1<R3
		P2	537.9 ±123.60	998			R2	540.9 ±122.68	995		
		P3	539.3 ±116.31	880			R3	545.2 ±118.32	417		
Flexed arm hang on bar [s]	P1	9.2 ±12.74	1312	<0.001	P3>P1, P2	R1	9.3 ±13.07	2091	0.011	R1<R3-	
	P2	9.3 ±13.20	1495			R2	9.7 ±13.07	1332			
	P3	10.1 ±13.06	1148			R3	9.9±12.32	532			
Strength- endurance	1-MBT [number of cycles]	P1	20.3 ±4.16	1312	<0.001	P1<P3	R1	20.2 ±4.21	2091	0.030	R1<R3
		P2	20.7 ±4.17	1495			R2	20.5 ±4.30	1332		
		P3	20.9 ±4.42	1148			R3	20.8 ±4.27	532		
	3-MBT [number of cycles]	P1	45.8 ±10.94	1001	<0.001	P1<P2, P3 P2<P3	R1	46.4 ±10.63	1467	<0.001	R1<R2, R3 R2<R3
		P2	47.6 ±10.47	998			R2	47.7 ±11.15	995		
		P3	48.6 ±11.25	880			R3	49.2 ±11.12	417		
Endur- ance	12-min rowing ergometer test [m]	P1	1576.3 ±226.71	1001	0.465	-	R1	1577.4 ±231.18	1467	0.307	-
		P2	1588.2 ±218.43	998			R2	1581.9	995		
		P3	1578.1 ±246.10	880			R3	1591.1	417		

SD – standard deviation; N - number of respondents; p - statistical significance; D - significant differences; \* - a lower number denotes a better score; P1 – rural area, P2 - city < 50,000, P3 – city > 50,000, R1 - < PLN 1500, R2 – from PLN 1501 to 3000, R3 - > PLN 3000; M1 – primary school/vocational school, M2 – secondary school, M3 – university, F1÷F3 - Father's educational background (identical criteria as in mother's educational background)

Table 4. Parents' educational background vs. motor indicators.

Indicators		Mother's educational background					Father's educational background				
		Group	Mean ± SD	N	p	D	Group	Mean ± SD	N	p	D
Speed/agility	8-s SHC [number of claps]	M1	24.4 ±3.98	1510	<0.001	M3>M1, M2 M3>M2	F1	24.8 ±3.79	1051	<0.001	F3>F1, F2
		M2	24.8 ±3.82	1727			F2	24.7 ±3.80	1991		
		M3	25.3 ±3.74	718			F3	25.3 ±3.91	913		
	4x10 m shuttle run* [s]	M1	12.7 ±1.06	1510	0.003	M1>M2, M3	F1	12.7 ±1.19	1051	0.464	-
		M2	12.7 ±1.08	1727			F2	12.7 ±1.10	1991		
		M3	12.6 ±1.15	718			F3	12.6 ±1.02	913		
	Zig-zag run* [s]	M1	29.7 ±2.49	1022	0.337	-	F1	29.6 ±2.37	695	0.300	-
		M2	29.5 ±2.46	1305			F2	29.6 ±2.53	1504		
		M3	29.6 ±2.55	552			F3	29.5 ±2.52	680		
Flexibility	Downward bend [cm]	M1	8.7 ±6.13	1510	<0.001	M1>M2, M3	F1	8.4 ±6.44	1051	0.136	-
		M2	7.6 ±6.42	1727			F2	7.9 ±6.19	1991		
		M3	7.6 ±6.25	718			F3	7.9 ±6.38	913		
	Barbell* overhead trunk rotation [cm]	M1	69.2 ±5.70	1022	0.001	M1>M2, M3	F1	69.0 ±5.69	695	0.001	F3<F1, F2
		M2	68.6 ±5.78	1305			F2	68.9 ±5.91	1504		
		M3	68.1 ±6.04	552			F3	68.0 ±5.73	680		
Strength	Standing broad jump [cm]	M1	161.5 ±19.45	1510	0.922	-	F1	161.6 ±19.27	1051	0.136	-
		M2	161.3 ±18.86	1727			F2	160.8 ±19.27	1991		
		M3	161.2 ±19.57	718			F3	162.4 ±19.00	913		
	30-s sit-ups [number of sit-ups]	M1	18.6 ±4.53	1510	<0.001	M3>M1, M2	F1	18.8 ±4.50	1051	<0.001	F3>F1, F2 F2>F1
		M2	19.1 ±4.49	1727			F2	19.2 ±4.61	1991		
		M3	19.8 ±4.38	718			F3	19.9 ±4.19	913		
	Medicine ball backward throw [cm]	M1	631.7±153.03	1510	0.013	M3>M1	F1	635.2 ±149.52	1051	0.003	F3>F1, F2
		M2	643.2 ±152.05	1727			F2	643.3 ±153.86	1991		
		M3	653.0 ±156.79	718			F3	659.4 ±156.51	913		
	Medicine ball forward throw [cm]	M1	524.7 ±114.71	1022	<0.001	M3>M1, M2	F1	532.0 ±128.04	695	0.001	F3>F1, F2
		M2	526.5 ±119.75	1305			F2	529.0 ±115.58	1504		
		M3	551.2 ±128.47	552			F3	550.6 ±121.28	680		
	Flexed arm hang on bar [s]	M1	9.7 ±12.92	1510	0.207	-	F1	9.6 ±13.14	1051	0.366	-
		M2	9.2 ±13.73	1727			F2	9.6 ±13.09	1991		
		M3	9.7 ±13.98	718			F3	9.3 ±12.80	913		
Strength- endurance	1-MBT [number of cycles]	M1	20.8 ±4.23	1510	0.127	-	F1	20.7 ±4.12	1051	0.007	F2<F3
		M2	20.5 ±4.20	1727			F2	20.4 ±4.36	1991		
		M3	20.6 ±4.42	718			F3	20.9 ±4.13	913		
	3-MBT [number of cycles]	M1	47.2 ±11.13	1022	0.854	-	F1	47.5 ±10.65	695	0.005	F2<F3
		M2	47.2 ±10.60	1305			F2	46.7 ±11.00	1504		
		M3	47.4 ±11.16	552			F3	48.2 ±10.84	680		
Endur- ance	12-min rowing ergometer test [m]	M1	1577.6 ±247.59	1022	0.510	-	F1	1574.4 ±227.11	695	0.039	F1<F3
		M2	1586.7 ±217.50	1305			F2	1577.4	1504		
		M3	1573.6 ±225.11	552			F3	1595.5	680		

SD – standard deviation; N - number of respondents; p - statistical significance; D - significant differences; \* - a lower number denotes a better score; P1 – rural area, P2 - city < 50,000, P3 – city > 50,000, R1 - < PLN 1500, R2 – from PLN 1501 to 3000, R3 - > PLN 3000; M1 – primary school/vocational school, M2 – secondary school, M3 – university, F1÷F3 - Father's educational background (identical criteria as in mother's educational background).

## DISCUSSION

An analysis of the relationships between socioeconomic factors and anthropometric characteristics revealed that the place of permanent residence and monthly budget were most strongly associated with body mass, body height and BMI. Similar tendencies were observed for mother's educational background, but this parameter exerted a strong influence on the surveyed

subjects' body mass and height in only two categories. In turn, father's educational attainment was a strong determinant of body height and BMI in all categories. A study conducted simultaneously on male university students also demonstrated significant relationships between the same environmental factors and the participants' body height and BMI, but not body mass [19]. Female students with higher monthly budgets who resided in large cities and were raised by mothers and fathers with university education were characterized by significantly lower body mass and BMI, which could result from observing healthy eating and lifestyle habits, including PA. Individuals with a higher socioeconomic status (SES) generally consume more vegetables and fruit [25], and they are more physically active [26]. Better educated parents are probably more likely to recognize the benefits of PA and a healthy diet, and the lifestyle adopted by the family enables the children to form healthy habits that are continued during university studies [27]. Similar conclusions were formulated by Adler and Newman [28] who observed that socioeconomic factors often impact health in a broader and less direct manner by shaping healthy behaviors and lifestyle.

The motor abilities of the evaluated female university students were influenced mostly by monthly budget (12 cases), followed by the place of permanent residence (10 cases), and father's and mother's educational background (9 and 8 cases, respectively). Monthly budget was also most highly correlated with the motor abilities of male university students, but the number of cases involving this and other environmental factors was lower than in female students [19]. A comparison of the results noted in female and male university students suggest that socioeconomic factors such as monthly budget, place of permanent residence, and parents' educational attainment exert a greater influence on the anthropometric characteristics and motor abilities of young women than men. Motor abilities are largely determined by PA levels [29], which implies that PA levels are more linked with environmental factors in current young females than in males [30].

Students from families with a high SES tended to have better motor abilities, which corroborates the findings of other authors [27, 31]. Jimenez Pavon et al. [32] studied adolescents from 9 European countries and found that higher SES was strongly associated with higher levels of motor fitness assessed based on cardiorespiratory fitness and muscular strength. Research conducted in the United States and Chile demonstrated that children from lower-income families tended to have lower motor fitness scores and were characterized by lower motor abilities in adulthood [33]. Similar findings were reported in an international study evaluating monozygotic and dizygotic twin pairs and more than 24,000 youths in Canada, Sweden, Denmark and Australia [34]. A significant decline in motor fitness, accompanied by an increase in body fat is generally observed among young women during their university years [35].

In the vast majority of cases, socioeconomic factors were correlated with all motor abilities (speed/agility, flexibility, strength, endurance-strength), excluding endurance (only one case). These observations indicate that socioeconomic factors significantly influence the PA levels of Polish female university students. In contrast, in a study evaluating the general motor fitness of young women enrolled in Polish universities in the Tricity area, the place of permanent residence did not exert a significant impact on the participants' performance [36]. In measurements of general motor fitness (based on the total T-score in tests such as medicine ball forward throw, standing broad jump, downward bend, and 4x10 m shuttle run), socioeconomic factors tend to exert a less direct influence on the participants' performance than in tests assessing specific motor abilities. The results of research studies investigating the correlations between SES, anthropometric characteristics and motor abilities also differ between countries and continents. In a study of Portuguese children, the association between SES and motor fitness varied for different indicators. Students from families with a higher SES did better in strength and running speed tests, whereas children with low SES outperformed their moderate- and high-SES peers in flexibility and endurance tests [37]. In a study of children and adolescents from South America (Brazil and Colombia) family SES was inversely correlated with motor fitness measures [38]. According to research, the potential relationships between SES, anthropometric characteristics and motor abilities are influenced not only by socioeconomic factors, but also by cultural and geographic factors as well as gender differences [27,30].

Since the lifestyle behaviors of academic youths are highly similar, doubts may arise as to whether it is justified to search for the cause and effect relationships between their social and



economic status vs. motor abilities [39]. Can motor abilities (which are a part of an individual's traits and are highly trainable in contrast to e.g. body height) be related to the social status? Students of different social backgrounds learn at the same universities, have access to the same academic and non-academic sports and recreation centers and facilities, are members of the same youth subculture and are affected by the same trends. Nevertheless, the results of this study indicate that such relationships exist because the levels of somatic and motor development of first-year female university students were found to be most strongly correlated their economic status and place of permanent residence (degree of urbanization) followed by their parents' educational background. An analysis of the above relationships should also account for the fact some motor abilities may be related (including in a non-linear manner) to body measurements or, in other words, somatic characteristics [40-42]. Numerous studies have shown that high body mass exerts a negative impact on the motor fitness test scores of female and male university students [35]. A study by Podstawski et al. [43] analyzed the correlations between selected anthropometric features (body mass, body height, BMI) and motor abilities in a group of first-year university students with nearly identical characteristics. In their study, body mass and BMI were significantly negatively correlated with the results of most motor tests. However, another study by Borysławski et al. [44] demonstrated that when PA levels were included in the analysis, this parameter was the key determinant of endurance-strength abilities. Methodological factors such as the research period, the methods applied to measure specific motor abilities, comparability of test conditions, and the classification criteria for different socioeconomic factors, also play an important role and can sometimes prevent reliable comparisons.

## **CONCLUSIONS**

Socioeconomic factors such as students' monthly budget, place of permanent residence, and mother's and father's educational background significantly influence the body mass, body height, BMI and motor abilities of first-year female university students. Students with a higher monthly budget, students residing in large cities, and students raised by better educated parents, were taller, had lower body mass and BMI, and scored higher in motor ability tests. Students' motor abilities (speed/agility, strength, strength-endurance, and flexibility) were most frequently and most significantly correlated with their monthly budgets, and were least frequently and least significantly associated with their parents' educational background.

## **DATA AVAILABILITY**

The Excel data used to support the findings of this study are restricted by the Ethics Committee of the University of Warmia and Mazury in Olsztyn (UWM), Poland in order to protect participants' privacy. Data are available from Robert Podstawski, E-mail: [podstawskirobert@gmail.com](mailto:podstawskirobert@gmail.com) for researchers who meet the criteria for access to confidential data.

## **CONFLICT OF INTEREST**

All Authors declare that there is no conflict of interests regarding the paper and its publication.

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