

Secular changes in the physical development of students of the Medical University of Łódź

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This study analyses, using selected somatometric features, secular trend changes which have occurred over a quarter of a century in female and male students of the Medical University of Łódź. The study is based on the results of an anthropometric survey carried out among first-year students who commenced their studies in the academic years 1978/79 (240 females and 193 males), 1982/83 (347 females and 188 males), 1988/89 (178 females and 165 males) and 2003/04 (188 females and 77 males). The following features were examined in all participants in the survey: body height (B-v), the height of the lower body segment measured from a floor base to the crista iliaca at the point on the mid-axillary line (B-ic), shoulder width (a-a), intertrochanteric distance (tro-tro) and resting chest circumference. To compare average values Student's t-test was used with assumptions of equal and unequal variances. To gauge the magnitude of changes in specific features in the course of a quarter of a century a percentage difference in results was calculated for the years 2003/2004 and 1978/1979. The basis for the calculations was the initial value of a feature at the beginning of the period analysed.

It was determined that in the 25-year period analysed (1978–2003) the young people commencing studies at the Medical University of Łódź exhibited an acceleration in the height of the lower body segment (B-ic) and of the intertrochanteric distance (tro-tro) and a deceleration in resting chest circumference. Additionally, an increase in shoulder width has been noted in female students; no significant intergenerational changes were noted in body height, although the last 15 years display certain symptoms of deceleration; there is an emerging tendency towards a blurring of the differences in body proportions between the sexes in the environment of the young people studying at the Medical University of Łódź.

Key words: secular trend, somatic development, somatometry

INTRODUCTION

The changes described as a “secular trend” are by nature non-evolutionary, adaptable and dependant on factors which include the acceleration of biological development of humans or the gaining of

greater final body dimensions in successive generations (acceleration).

A secular trend is attributed to the development of civilization, spawning socioeconomic changes directed towards the improvement of

living conditions. It has also been believed that genetic factors play an important role here in association with the “breaking of genetic isolation” and its resultant heterosis effect [10]. Within the genetic framework a certain significance is attributed to tendencies in the perinatal and marital selection of short individuals [12]. According to Henneberg [6], intergenerational changes exhibiting the characteristics of a secular trend involve specific generational factors which influence the determinant and regulatory functions of the genes responsible for body growth. Such a role may be played by some of the protective vaccines, antibiotics and bio-substances and the chemicals used in livestock breeding to foster body size and mass and in farming to enhance crops. As a result, meat and animal products, such as milk or butter, and vegetables may potentially be able to stimulate and modify the endocrine system, chiefly to secrete human growth hormone.

The tendency of changes is most often described using the example of body height and mass, but several works have also taken into account other somatometric and even motoric features [3, 8]. Research so far shows that acceleration is not uniform across various features and hence results in traits such as a gradual slimming of the average figure [8, 11]. Intergenerational changes are more distinct in males than in females, which is related to the variation in sensitivity of girls and boys to environmental variables [1, 3, 9, 19].

The purpose of this paper is to analyse, using selected somatometric features, intergenerational changes which have occurred over a quarter century in female and male students of the Medical University of Łódź.

MATERIAL AND METHODS

The study is based on the results of an anthropometric survey carried out by Zieleniewski among first year students who commenced their studies in the following academic years: 1978/79 (240 females and 193 males), 1982/83 (347 females and 188 males), 1988/89 (178 females and 165 males). These data have not been published in full and were made available by courtesy of the author. To trace the changes occurring in a broader time-frame an additional survey was conducted internally by students of 2003/04 (188 females and 77 males).

The following data was determined for all the individuals who participated in the survey: body height (B-v), the height of the lower body segment

measured from a floor base to the crista iliaca at the point on the mid-axillary line (B-ic), shoulder width (a-a), intertrochanteric distance (tro-tro) and resting chest circumference. The selection of measurements was dictated by a survey plan applied in previous years by Zieleniewski.

On the basis of our own findings individual calculations were made of the following indices: the height of the lower body segment B-ic/B-v), shoulder width (a-a/B-v) and intertrochanteric width (tro-tro/B-v). We present these data for their eventual use in further analyses. These parameters cannot be compared in the present study owing to the lack of indices for previous years.

To compare average values Student's test has been used with assumptions of equal and unequal variances.

To gauge the magnitude of changes in specific features in the course of a quarter of a century a percentage difference in the results has been calculated for the years 2003/2004 and 1978/1979. The basis for the calculations was the initial value of a feature at the beginning of period analysed.

RESULTS

Analysis of the body height of females indicates a moderate (0.4–0.6 cm) increase in average values for this feature in consecutive year groups up to end of the 1980s. The latest examinations indicate a slight decrease in average body height in comparison with the results for female students commencing their studies in the academic year 1988/89 (0.4 cm). However, the differences observed did not reach the level of statistical significance level assumed. Female students surveyed in the year 2003 were on average only 0.6 cm taller than their peers from 25 years before (the difference is statistically insignificant).

In the male group under examination a similar, although clearer, tendency emerged. This applies in particular to the increase in average body height in the 4-year period of 1978–1982, amounting to 2.1 cm and proving to be statistically significant ($p < 0.01$). In the following six-year period only a small (0.3 cm), statistically insignificant, increase was observed. The latest results, in turn, show a decrease of 1.6 cm in the value studied compared to the research from 15 years earlier (the magnitude of this change proved statistically insignificant). The difference between average values from extreme year groups amounted to 0.8 cm and was not statistically significant.

A gradual increase characterised the height of the lower body segment in female students throughout the entire period surveyed. In the first 4-year period analysed the increase was small (0.3 cm), not reaching the significance threshold. In the course of the next 6 years the increase attained 1.5 cm ($p < 0.01$) and in a 15-year period (1988–2003) 3.7 cm ($p < 0.001$). The overall increase in the average value of this feature over a quarter of a century amounted to 5.5 cm ($p < 0.001$).

In male students the increase in height of the lower body segment in the first four years surged by 3.3 cm ($p < 0.001$), while in the next six-year frame the average value dropped by 1.7 cm ($p < 0.01$). After this it increased by 2.6 cm ($p < 0.001$) over the next 15 years. The average value of this parameter increased by 4.2 cm ($p < 0.001$) over the 25-year period analysed.

In the female group commencing studies in 1982/83 shoulder width turned out to be on average 0.7 cm ($p < 0.001$) smaller than that in their peers surveyed four years earlier. In the period between 1982 and 1988 an increase of 1.4 cm was observed ($p < 0.001$) and in the 15 following years (1988–2003) one of 1.0 cm ($p < 0.05$). Shoulder width of currently surveyed students was on average 1.7 cm greater than that of their peers of 25 years earlier.

In male students shoulder width did not change over the first period analysed (1978–1982). Over the next six years it increased by 1.4 cm ($p < 0.01$), while in the next 15 years it decreased by 0.7 cm (a statistically insignificant difference). Currently shoulder width in male students is 0.7 cm greater than that in their peers surveyed a quarter of a century earlier (a change which lacks statistical significance).

The intertrochanteric width in females does not reveal any statistically significant differences between the groups compared (0.1–0.4 cm). Over 25 years the average value of the feature increased by 0.5 cm ($p < 0.01$).

In male students the changes were also insignificant in the first two periods (0.1–0.3 cm), but over the last 15 years the average value of this feature has increased by 0.8 cm ($p < 0.05$). Overall the average value of the intertrochanteric width in males has increased by 1.0 cm ($p < 0.01$) over the 25-year period.

The average chest circumference in the female students surveyed increased slightly (0.2 cm, statistically insignificant) in the four-year period 1978–1982. Within the next six years a decrease in the average value of 2.0 cm ($p < 0.001$) had been

noted, rising to 3.4 cm in the course of the next 15 years ($p < 0.001$). The total reduction in resting chest circumference over the 25-year period amounted to 5.2 cm ($p < 0.001$).

In the male group a clear increase of 2.9 cm in chest circumference occurred in the years 1978–1982 ($p < 0.001$). Over the next six years a statistically insignificant (0.7 cm) decrease was observed, followed in the next 15 years by a further very clear decrease of 4.6 cm ($p < 0.001$). Overall, the reduction in chest circumference over the 25-year period amounted to 2.4 cm ($p < 0.01$).

When the degree of change for each somatometric feature was compared over the 25-year period, the strongest symptoms of acceleration were noted in the height of the lower body segment in both sexes (6.3% in females and 4.5% in males). In female students, additionally, a large increase in shoulder width occurred (5.1%). In the case of male students the value of this feature increased to a much smaller degree, while a slightly more marked increase was observed in their intertrochanteric distance (3.1%). In the female group surveyed the average value of this feature increased by only 1.6% in comparison with the average for the years 1978/1979. The weakest symptoms of acceleration occurred in the body height of the young people studying in the Medical University of Łódź (0.4% for females and 0.5% for males). A clear deceleration was observed in resting chest circumference, particularly in females (–6.5% in females, –2.5% in males) (Tables 1 and 2).

DISCUSSION

Observations of the somatic features of the Polish population have been conducted for over one hundred years. These have been complemented by surveys of young people in academic institutions, including students of medical schools. Analyses of this kind allow for examination of layered trends, intergenerational changes which occur in a group isolated from the general population who have the opportunity to realise, relatively fully, their genetic potential for development.

It is generally considered that 10 years is the shortest possible period for judging acceleration phenomena. Hence the data cited in this paper for periods of 4 and 6 years should be treated as a picture of fluctuation in the physical development of students of the Medical University in Łódź and perhaps, eventually, as a data source for further comparisons. Assessment of intergenerational changes is based therefore on the last 15 and 25-year periods.

Table 1. Metric characteristics of female students of Medical University in Łódź

Feature	Parameter	I	II	III	IV	Groups compared (time span) [years]	Diffs. between groups [cm]	Difference between extreme groups (I-IV)
		1978/1979	1982/1983	1988/1989	2003/2004			
B-v	n	240	347	178	188	II-I (4 years)	0.6	
	× [cm]	164.6	165.2	165.6	165.2	III-II (6 years)	0.4	
	SD	5.6	5.6	4.9	6.2	IV-III (15 years)	-0.4	
	Value range	153-181	150-180	154-176	148.5-179.1			
	v	3.37	3.36	2.94	3.74	IV-I (25 years)	0.6	0.4%
B-ic	n	240	347	178	188	II-I (4 years)	0.3	
	× [cm]	87.9	88.2	89.7	93.4	III-II (6 years)	1.5**	
	SD	5.94	5.94	5.09	5.3	IV-III (15 years)	3.7***	
	Value range	69-101	70-102	77-104	88.0-112.5			
	v	6.75	6.73	5.68	5.56	IV-I (25 years)	5.5***	6.3%
a-a	n	240	347	178	188	II-I (4 years)	-0.7**	
	× [cm]	33.5	32.8	34.2	35.2	III-II (6 years)	1.4***	
	SD	3.13	3.12	3.37	5.5	IV-III (15 years)	1.0*	
	Value range	28-40	29-42	28-41	30.0-42.5			
	v	9.34	9.51	9.87	15.63	IV-I (25 years)	1.7***	5.1%
tro-tro	n	240	347	178	188	II-I (4 years)	-0.1	
	× [cm]	31.8	31.7	31.9	32.3	III-II (6 years)	0.2	
	SD	1.90	1.90	2.72	1.9	IV-III (15 years)	0.4	
	Value range	28-36	27-37	27-38	29.0-38.5			
	v	5.97	5.99	8.52	5.8	IV-I (25 years)	0.5**	1.6%
Chest circumference	n	240	347	178	186	II-I (4 years)	0.2	
	× [cm]	79.7	79.9	77.9	74.5	III-II (6 years)	-2.0***	
	SD	6.0	6.0	5.5	5.7	IV-III (15 years)	-3.4***	
	Value range	71-95	72-96	68-99	54-116			
	v	7.49	7.47	7.08	7.69	IV-I (25 years)	-5.2***	-6.5%
B-ic/B-v	n	—	—	—	188	—	—	—
	× [%]	—	—	—	57.7	—	—	—
	SD	—	—	—	1.8	—	—	—
	Value range	—	—	—	53.8-65.6	—	—	—
	v	—	—	—	3.0	—	—	—
a-a/B-v	n	—	—	—	188	—	—	—
	× [%]	—	—	—	21.3	—	—	—
	SD	—	—	—	1.0	—	—	—
	Value range	—	—	—	18.9-26.1	—	—	—
	v	—	—	—	4.8	—	—	—
tro-tro/B-v	n	—	—	—	188	—	—	—
	× [%]	—	—	—	19.6	—	—	—
	SD	—	—	—	1.1	—	—	—
	Value range	—	—	—	17.2-23.0	—	—	—
	v	—	—	—	5.6	—	—	—

*p < 0.05; **p < 0.01; ***p < 0.001

Table 2. Metric characteristics of male students of Medical University in Łódź

Feature	Parameter	I	II	III	IV	Groups compared (time span) [years]	Diffs. between groups [cm]	Difference between extreme groups (I-IV)
		1978/1979	1982/1983	1988/1989	2003/2004			
B-v	n	193	188	165	77	II-I (4 years)	2.1**	
	× [cm]	177.0	179.1	179.4	177.8	III-II (6 years)	0.3	
	SD	6.3	6.5	6.6	5.2	IV-III (15 years)	-1.6	
	Value range	157-193	165-194	160-195	160.6-191.1			
	v	3.54	3.60	3.69	3.88	IV-I (25 years)	0.8	0.5%
B-ic	n	193	188	165	77	II-I (4 years)	3.3***	
	× [cm]	94.1	97.4	95.7	98.3	III-II (6 years)	-1.7**	
	SD	5.0	5.5	5.9	5.2	IV-III (15 years)	2.6***	
	Value range	80-103	82-115	83-119	93.6-120.6			
	v	5.35	5.66	6.18	5.18	IV-I (25 years)	4.2***	4.5%
a-a	n	193	188	165	77	II-I (4 years)	0.0	
	× [cm]	39.1	39.1	40.5	39.8	III-II (6 years)	1.4***	
	SD	3.7	4.0	4.6	2.2	IV-III (15 years)	-0.7	
	Value range	30-47	31-45	30-53	36-45			
	v	9.51	10.15	11.40	5.40	IV-I (25 years)	0.7	1.8%
tro-tro	n	193	188	165	77	II-I (4 years)	0.3	
	× [cm]	32.6	32.9	32.8	33.6	III-II (6 years)	-0.1	
	SD	2.3	2.5	2.4	3.1	IV-III (15 years)	0.8*	
	Value range	28-48	30-43	27-46	28.5-53.0			
	v	6.99	7.72	7.23	9.24	IV-I (25 years)	1.0**	3.1%
Chest circumference	n	193	188	165	76	II-I (4 years)	2.9***	
	× [cm]	94.8	97.7	97.0	92.4	III-II (6 years)	-0.7	
	SD	5.5	5.7	9.6	8.5	IV-III (15 years)	-4.6***	
	Value range	77-113	80-114	84-120	76-112			
	v	5.78	5.83	9.86	9.17	IV-I (25 years)	-2.4**	-2.5%
B-ic/B-v	n	—	—	—	76	—	—	—
	× [%]	—	—	—	56.4	—	—	—
	SD	—	—	—	1.6	—	—	—
	Value range	—	—	—	56.7-64.5	—	—	—
	v	—	—	—	2.6	—	—	—
a-a/B-v	n	—	—	—	76	—	—	—
	× [%]	—	—	—	22.4	—	—	—
	SD	—	—	—	0.9	—	—	—
	Value range	—	—	—	20.0-24.2	—	—	—
	v	—	—	—	4.1	—	—	—
tro-tro/B-v	n	—	—	—	76	—	—	—
	× [%]	—	—	—	18.9	—	—	—
	SD	—	—	—	1.6	—	—	—
	Value range	—	—	—	16.5-28.8	—	—	—
	v	—	—	—	8.3	—	—	—

*p < 0.05; **p < 0.01; ***p < 0.001

Research carried out so far indicates that the process of acceleration does not affect all features to the same degree. The literature indicates that a varied acceleration of development in body height and body mass leads to slimming of the average figure [2, 8, 11, 13, 17]. It is also considered that acceleration does not apply to body trunk length [11, 17] or the depth of the chest [11]. Over the years, however, a broadening of the chest and shoulders can be observed as well as a narrowing of hips [2, 10, 11, 17]. In addition, change occurs in the proportions between the upper and lower extremities [17].

Our own research does not analyse all the variables addressed by the above authors. However, a clear differentiation has been observed between various features in the intensity of the secular trend manifested. In the group surveyed acceleration of the height of the lower body segment (B-ic) appeared to be particularly marked. Data from the literature appear to confirm that the lower extremities become longer [7, 10, 17, 18], although doubts emerge with regard to the magnitude of the changes noted by us in the quarter of a century analysed (5.5 cm in female students and 4.2 cm in males). Undoubtedly, this problem requires further analyses to verify the results obtained.

Our research indicates that over the last quarter of a century a conspicuous broadening of the shoulders has occurred (5.1%). Acceleration of this feature seems to be confirmed by other authors [10, 11, 17]. Surprisingly, in the group of males tested these changes were slight and statistically insignificant (1.8%) and over the last 15 years even exhibited symptoms of deceleration. We obtained, however, quite different results for intertrochanteric width. In contrast to several reports indicating a tendency towards narrowing of the pelvis [2, 10, 11, 17], the intertrochanteric width we analysed (indirectly indicative of hip band development) underwent clear broadening, especially in males (3.1%). The shape of these two features surveyed in female and male students indicates a change in the proportions of their bodies towards light feminisation in males and masculinisation in females.

The results of resting chest circumference are also of interest, showing, particularly in women, a clear tendency to a reduction in the average value over the entire period surveyed (–6.5% in female students, –2.5% in male students). Contrary to these were the results obtained by Dutkiewicz [5] when analysing data for the last century for children and young people from 9 to 21 years of age from the Kielce region.

Research by Malinowski [11] also allows the conclusion to be drawn that widening of a chest accompanied by the absence of changes in its depth has caused the increase in its circumference. Perhaps the reasons for these discrepancies should be sought in the environmental and social peculiarities of the acceleration process.

The weakest change over the period of 25 years has been noted in the body height of the individuals surveyed. The average value of this feature increased in that period by a mere 0.4% for females and 0.5% for males, thus not reaching levels of statistical significance. In contrast to our results those of other authors have led to the conclusion that there has been a marked acceleration of body height (3.8 cm). Pełowski, for example, [15] assessed a 20-year period (1966–1986) of somatic development of female medical students in Lublin and Deckert [4] recorded an increase in average body height of about 5 cm in students of both sexes at the Medical Academy in Poznań over a 40-year period (1954–1994). In our own research the body height of young people commencing studies in recent years (2003/2004) even exhibits certain signs of deceleration, particularly in males (–1.6 cm) in comparison with data from 15 years earlier. Similar observations were made by Stolarczyk et al. [16], who, on the basis of analysis of data for children and young people in Łódź from 1948 to 1993 and in Poznań from 1980 to 1992, identified in the last period analysed (after 1990) a deceleration not only of body height but also of body mass, particularly visible in the Łódź environment. Nowicki [14], in turn, pointed to the arrested secular trend in body height and mass in the Bydgoszcz region in the years 1971–1991. The above results may be a manifestation of worsening socio-economic conditions in the country, which is implied by the authors of these papers.

CONCLUSIONS

1. In the 25-year period analysed (1978–2003) the young people commencing studies at the Medical University in Łódź exhibited an acceleration of the height of the lower body segment (B-ic) and of the intertrochanteric distance (tro-tro) and a deceleration of resting chest circumference. Additionally, in female students, an increase in shoulder width was noted.
2. No significant intergenerational changes were noted in body height, although in the last 15 years certain symptoms of deceleration of this feature have been displayed.

3. There is an emerging tendency towards a blurring of the differences in body proportions between the sexes in the environment of the young people studying at the Medical University of Łódź.

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