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Growth and Public Health Concerns – Proceedings of the 29th Aschauer Soiree, held at Krobielowice, Poland, November 20th 2021

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Abstract

Seventeen scientists met for this year's conference on Auxology held at Krobielowice castle, Poland, to discuss growth and public health concerns. The regulation of growth is complex. Besides metabolic and endocrine components including hypothalamic releasing hormones, growth hormone, and multiple downstream effectors, the regulation comprises the full spectrum of upstream influencers coming from the psychosocial, economic, and emotional environment including signaling dominance, competence, prestige, or subordination and indulgence, all of this being sensitive to urban or rural lifestyle, the political climate, and with marked plasticity throughout history. New statistical techniques (St. Nicolas House Analysis) are presented for analyzing anthropometric variables for public health concerns. The impact of spatial differences on developmental tempo, growth in height, and the prevalence of childhood obesity are discussed as well as the impact of social mobility on obesity, and the benefits of the biopsychosocial status when getting along with socio-economic disasters and the COVID-19 pandemic.

Take home message for students The regulation of growth does not only include metabolic and endocrine components, but comprises the psychosocial, economic and emotional environment, and is sensitive to lifestyle and the political climate.

Proceedings

Seventeen scientist met for this year's conference on Auxology (Hermanussen et al. 2021b; Scheffler et al. 2021b) held at Krobielowice castle, Poland, to discuss growth and public health concerns. The regulation of growth is complex. Besides metabolic and endocrine components including hypothalamic releasing hormones, growth hormone, and multiple downstream effectors, the regulation comprises the full spectrum of upstream influencers coming from the psychosocial, economic, and emotional environment including signaling dominance, competence, prestige, or subordination and indulgence.

Michael Hermanussen discussed arithmetic dilemmas when calculating the prevalence of thinness, overweight, and obesity in populations that are shorter or taller than the growth references used for that particular population. Based on virtual child populations with normally distributed height and weight he showed that body mass index (BMI)-for-age z-scores (BAZ) depend on height and age (Hermanussen et al. 2022). In short children (mean height for age z-scores (HAZ) = -2 to -3, the prevalence of thinness when defined by BAZ, falls to less than 1% in the youngest children, and rises up to 11% (mean HAZ=-2) and up to 14% (mean HAZ=-3) at age 10 years. At the same time, the prevalence of obesity rises to up to 7% in the shortest and youngest, and falls close to zero at age 10 years indicating that the nutritional status of children from very short or very tall populations is prone to be seriously misclassified. This dilemma represents a significant public health concern, and appears to particularly affect the very young children within very short populations.

Christiane Scheffler presented considerations regarding a universal "motivation to grow" based on a recent study among 30 male and 54 female young adult Vietnamese migrants in Germany (Scheffler et al. 2021a). Migrants have been shown to adjust in height to their host communities (Bogin et al. 2018) due to multiple social-economic-political and emotional (SEPE) factors (Bogin 2021). This was also true for young adult Vietnamese migrants who were significantly taller than their parents (women 3.85 cm, men 7.44 cm), and almost fully attain the height of their German peers. Particularly height of their best friends and the anticipated desired adult height at age 13 years appeared important. The author then outlined the complex feedback mechanism that regulates child and adolescent growth and includes the endocrine arm of the feedback circle and the social arm (Figure 1). The common concept of understanding the regulation of growth starts with the release of so-called hypothalamic releasing hormones: the stimulating growth hormone releasing hormone (GHRH) and the inhibiting somatostatin. These neuropeptides then regulate growth hormone secretion and downstream, insulin-like growth factors and metabolism. This understanding, however, appears to be only part of the full regulatory circle as it lacks the impact of psychological and social effects. Acquiring social status and individual positioning within a social network is essential, and it requires signaling. Signaling dominance, competence, and prestige, or subordination and indulgence depends on the appropriate signals among which physical body size and behavioral features are of greatest importance. Recent work on intermale aggression to establish social rank suggests that dopamine transporter-expressing neurons in the hypothalamic ventral premammillary nucleus (PMvDAT neurons) organize goal-oriented aggression in male mice. Activation of these neurons triggers attack behavior (Stagkourakis et al. 2018); but the same neurons

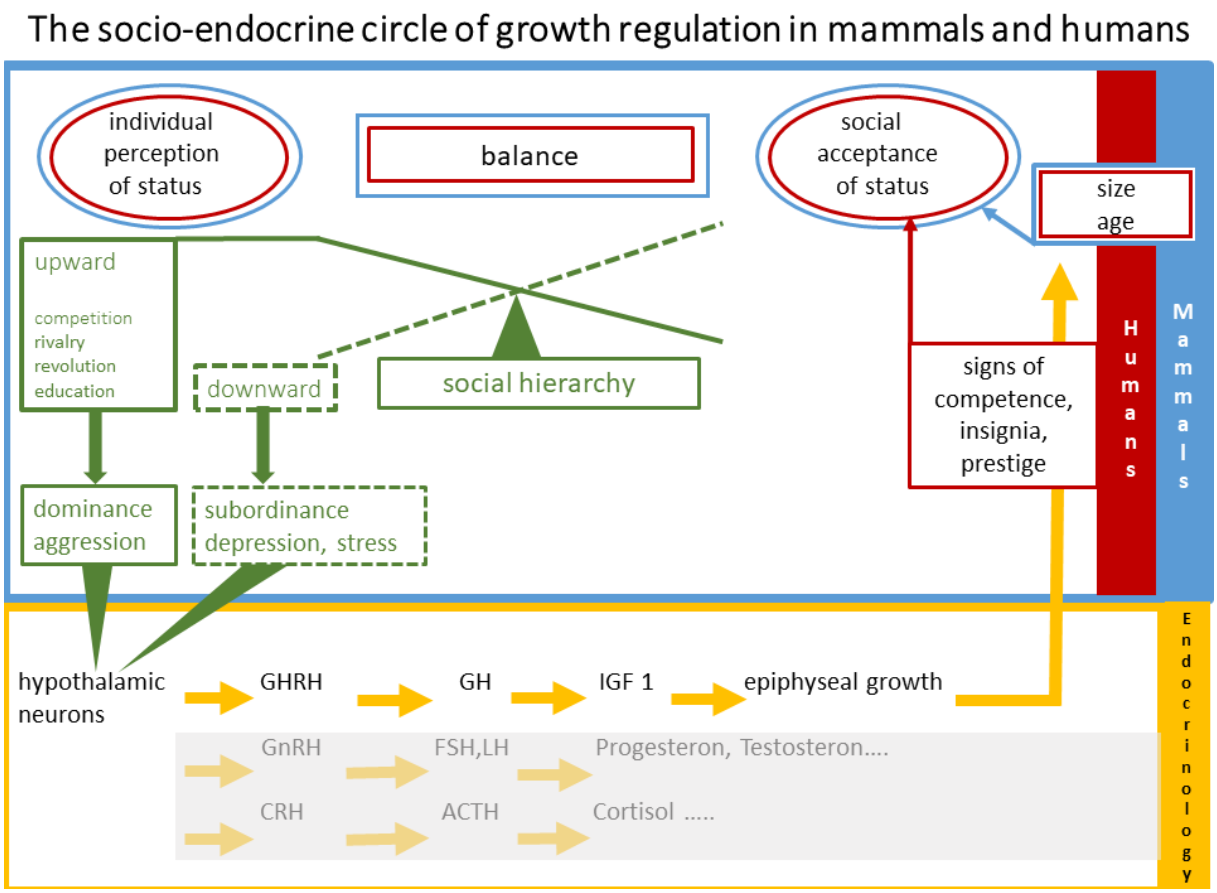

Figure 1 The socio-endocrine circle of growth regulation. Signals of dominant or subordinate behavior passing through hypothalamic neurons transmit the appropriate growth impulse via growth hormone releasing hormone (GHRH), growth hormone (GH) and insulin-like growth factor (IGF) 1 to the epiphyseal growth plate. Growth in height results to that physical size which dispatches the corresponding social signal of competence and prestige, or inaptitude. The physical signal either reflects, or rather does not reflect the balance between self-perception and social acceptance. Interacting with social and environmental, as well as political and emotional cues, this balance will then result in behavioral responses within the social hierarchy that close the socio-endocrine circle of growth regulation.

are also key integrative nodes for metabolic cues and project to and directly stimulate kisspeptin and gonadotropin releasing hormone (GnRH) neurons (Lee et al. 2021). Although PMvDAT neurons stay in close local vicinity to those arcuate nucleus neurons that release GHRH, the details of these neuronal circuits still remain to be elucidated. Currently available data thus strongly suggest that the socio-endocrine regulation of growth is driven by social cues, and the balance or imbalance of self-esteem within the social network.

Liza Wilke compared historic height and weight of 6 and 7 year old Munich school girls of different socio-economic background from 1914 (Dikanski 1914), with German reference data from the 1980s (Greil 1988), and modern WHO references (Wilke et al. 2022). Girls of the affluent class were on average 5.23cm and 1.7kg (6-year-old) and 7.7cm and 3kg (7-year-old) shorter and lighter than German children in the 1980s, and 3 cm and 0.7kg (6-year-old) and 5cm and 1,8kg (7-year-old) shorter and lighter than WHO references. Even under optimum environmental conditions, urban children from 1914 did not reach the average of modern children. İn addition, the author showed that the historic body weight distributions did not follow modern references either. In contrast to current

wisdom – body weight is supposed to be skewed to the right – historic weights followed a symmetric Gaussian distribution in affluent as well as middle and working class children.

Sonja Böker (Böcker et al. 2022) discussed whether skeletal age is the only appropriate measure to validate biological age based on dental, skeletal and height data. The data were derived from N=6529 middle socio-economic status (SES), N=736 low-middle SES, N=3653 low SES Ladino, and N=4587 low SES Maya boys from Guatemala, aged between 7 and 12, collected between the 1970s and 1990s. Low SES Mayas are short. Their shortness is associated with very poor social conditions (Bogin and MacVean 1984) and closely corresponds with the delay in skeletal age. Yet, the correlations between height and dental maturation and dental maturation and skeletal age were low and explained less than 10 % of the variance in height. The author concluded that dental development is regulated by different mechanisms than skeletal development and growth and matures at a different pace. Tooth eruption is sensitive to nutritional status, whereas skeletal age appears more sensitive to the socioeconomic background.

Detlef Groth presented a graphical user interface to the St. Nicolas House Algorithm (Hermanussen et al. 2021) as only few people appear to be acquainted with the statistical software R that at this moment is exclusively used for this type of analysis. Using the graphical interface only requires a standard R installation; the R-script is embedded for MacOSX and Linux as an easy to use single file executable, while Windows provides an installer using NSIS. The user interface is built using R's tcltk package. Data may then be loaded from Excel and Tab files. Currently, main features are available, with a flexible selection of correlation methods, p-values and bootstrapping. Results can be reported as Excel-files, graphics can be saved as PDF files.

Sylvia Kirchengast and Dominik Hagmann presented a study on spatial differences on the prevalence of childhood obesity in Vienna, Austria. In recent years, the impact of environmental factors has increasingly come into focus (Townshend and Lake 2017). Safe neighborhoods provide a range of local facilities within walking and cycling distance, with good quality infrastructure, such as well-maintained pavements. They reduce the risk of overweight and obesity, in contrast to so-called obesogenic environments (Hobbs and Radley 2020) that are mainly found within urban centers. Advancing urbanization has dramatically altered the living situation as well as human behavior along with the health situation and disease burden, but little is known about the intra-urban differences in childhood obesity rates (Lakes and Burkart 2016). As part of a cooperation project starting in 1994 at the University Clinic for Pediatrics, Medical University of Vienna, the authors analyzed intra-urban patterns of childhood overweight and obesity in Vienna in view of the socio-demographic environment. Based on medical record-based data sets, 46 public secondary schools were randomly selected, with 1611 children aged 6, 10, and 15 years. The urban structure varied widely across the 23 districts and included densely populated areas in the city center, as well as single family homes in the suburban areas. The population was extremely heterogeneous with about 47% having a migratory background. 55% of children between 6 and 16 years did not speak German at home. The study demonstrated distinct spatial differences in the distribution of overweight/obesity during childhood and adolescence within the city. A large share of the intra-urban distribution was explained by spatial differences in socio-economic parameters, first of all by the percentage of migrants in the area.

The highest rates of childhood and adolescent overweight/obesity were found in the 10th and 15th districts, both characterized by very low SES, poorer living conditions, and a high rate of inhabitants with a migratory background. The prevalence of overweight and obesity among children and adolescents who lived in "wealthier" districts and cluster areas, was lower even when these children belonged to the lower social strata.

Lidia Lebedeva and Elena Godina studied regional differences in the tempo of secular growth changes during the 19th and 20th centuries in different areas of Russia and neighboring countries. They hypothesized that there were some areas with stable short and tall statures. They used datasets with as a large number of territorial units of the country as possible (Anuchin 1889; Bunak 1932; Purundzhan 1978). The authors added new sources of information obtained from the RLMS HSE (The Russia Longitudinal Monitoring Survey – Higher School of Economics https://rlms-hse.cpc.unc.edu/) dataset. In contrast to the former, the latter data consisted of recall information on height. Regions with predominantly tall stature were identified: near the Baltic Sea and Saint Petersburg and between the contemporary cities of Kiev and Krasnodar. Regions with predominantly short stature were found in the central part of the Volga River region. This was confirmed in both the historic and the contemporary datasets. Secular changes in height for different regions and time periods were uneven, which may be connected with the different ethnic composition of the studied populations and different socioeconomic and demographic variables (Table 1). For most of the examined regions the biggest increase in height occurred either after World War II, or at the end of the 20th century.

Aleksandra Gomula presented data on maturation and physical performance in children exposed to lead. Lead exposure is known for its growth inhibiting and neurotoxic effects, including reduced head growth and impaired intellectual, neuropsychological, and behavioral functioning. Blood lead levels should range <5μg/dL (https://www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm). Yet, higher levels of blood lead concentrations are often found in areas with metallurgical and mining industries, such as in the Copper Basin in Poland (Nowak-Szczepanska et al. 2021). The present study included over 1140 school-children aged 7–16 years (mean age=10.8, SD=2.54) from Polkowice town. However, the exact number and age range varied depending on the trait studied and the year of study. Polkowice community is known to be one of the richest communities in Poland and homogeneous in terms of SES. The children were divided into two groups: 3.7μg/dL, and >3.7μg/dL, based on median value of blood lead level in 2008. Studies conducted in 1996 and 2008 revealed that children with higher blood lead levels were significantly slimmer than those less exposed. Children, with lower body weight, lower skinfold thickness, lower mid-upper arm circumference, lower BMI (Nowak-Szczepanska et al. 2021), and lower hand grip strength ($p<0.001$), the latter irrespective of sex, age and BMI; differences in height were insignificant. Also, age at menarche, obtained by the status quo method, was significantly delayed in the lead exposed group, with 12.6±1.3 years for girls <3.7μg/dl and 12.9±1.1 years for girls 3.7μg/dl ($p<0.01$) (Gomula et al. 2022) Gomula concluded that even currently accepted blood lead levels of 5μg/dL should still be considered conspicuous as they may imply harmful effects on growth and development of children and young adolescents.

Jan M. Konarski presented a study on secular changes in height and weight in school children and adolescents, aged 7–15

Table 1 Changes in male height (aged 22–35 years) according to selected regions and time periods (only Russian participants except for Kiev/Ukraine).

Changes in height (cm)	All data (averag values)	Kiev re-gion*	Moscow region	Saint-Peters-burg region	Tula region	Krasnoda region	Stavrop region	Sara-tov re-gion	Tam-bov region	Penza region	Oren-burg region	Perm region	Vladivos-tok region
Birth cohorts from 1853–1863 to 1906–1909 (years 1880's-1930's)	3.1	3.1	3	2.1	2.6	2.1	3	3.3	3.5	3.1	3.8	1	3.9
Birth cohorts from 1906–1909 to 1952–1956 (years 1930's-1970's)	3.1	5.3	5.5	5.7	6.7	5.6	4.6	4.7	2.5	6.7	3.7	2.9	1.7
Birth cohorts from 1952–1956 to 1961–1996 (years 1970's-2000's)	6.5	3.7	6.1	5.3	6.2	2.6	3.2	5	8.1	1	6.4	8.2	7.2
Total increase	12.7	12.1	14.6	13.1	15.5**	10.3	10.8	13	14.1	10.8	13.9	12.8	12.8**

*age range 19–22 years

**only urban areas

years of 10 rural communities of West-central Poland between 1986 and 2016 (Bartkowiak et al. 2021), with particular emphasis on changes within each of the communities. In the four surveys the samples consisted of 1417 boys and 1326 girls in1986, of 979 boys and 947 girls in 1996, of 871 boys and 843 girls in 2006, and of 1189 boys and 1105 girls in 2016. Konarski considered the increments in height, weight and BMI in each village over 30 years relative to the height, weight and BMI in 1986 in each of the villages. He used sex- and village-specific ANCOVAs across surveys, with age and age squared as covariates. Age-adjusted means were plotted subsequently and sex-specific correlations between gains in each community across 1986–2016 and size at baseline (1986). He included partial correlations controlling for geographic distance from Poznań and population growth. Table 2 illustrates the correlations between mean increments in height, weight and BMI from 1986 to 2016 in each of the 10 rural communities with the baseline values in 1986.

Konarski concluded that the relation between increments in weight and BMI over 30 years and size at baseline (1986) were negative and moderate-to-high in boys and girls; those for height were moderate and negative in boys and low and positive in girls. The correlations between increments over 30 years with the geographic distance from Poznań and population growth did not consistently influence the observed relationships.

During the growth period from early childhood to the end of adolescence, changes occur in the size and proportions of the lower and upper segments, and thus boys and girls grow at different paces. Ayşegül Özdemir Başaran and Başak Koca Özer presented a study that aimed at evaluating the height, and the upper and lower segment measurements of children and adolescents from Turkey. The cross-sectional survey was conducted on 1,484 (761 boys and 723 girls) schoolchildren aged 6–17 years living in Ankara, the capital city. Within the scope of the study, height, forearm, and lower leg length measurements were taken,

Table 2 Correlations and partial correlations controlling for the geographic distance from Poznań, population growth (1986–2016), and both distance and population growth for each community (*p<0.05, **p<0.01).

	Gains 1986–2016		
Ht/Wt/BMI in 1986	Height	Weight	BMI
BOYS	-0.62	-0.94**	-0.51
Control distance	-0.45	-0.92**	-0.52
Control pop growth	-0.37	-0.93**	-0.54
Control pop & dist	-0.34	-0.92**	-0.50
GIRLS	0.29	-0.42	-0.75*
Control distance	0.34	-0.41	-0.76*
Control pop growth	0.29	-0.41	-0,76*
Control pop & dist	0.52	-0.36	-0.74*

following the standard protocols, and the tibio-radial index was calculated. According to the results, until the ages of 9–11 years, similar values were observed in both sexes, while the mean values are higher in boys afterwards and both the forearm and lower leg values differed significantly between sexes after the age of 13 (Table 3). Due to the significant increase in the lower leg length, the height values present the same tendency between sexes ($p<0.001$). The tibio-radial index showed higher values in both sexes at ages 6 and 7 years. The forearm growth is more pronounced than lower leg growth at these ages. It is worth mentioning that the higher tibio-radial index values in both sexes at the end of the growth process are due to the acceleration of growth in the lower leg length. The tibio-radial indexes differed significantly between the sexes only at the ages of 8 and 12 years ($p<0.05$). At 8 years, boys' forearms were relatively longer, whereas at 12 years, boys' lower legs were relatively long. Since the 1970s, the height values for Turkish children have increased prominently (Günöz et al. 2014), and present findings show a similar tendency: recent forearm, and lower leg lengths are longer than in former studies. Positive secular increases are related to the improvement in socio-economic and environmental conditions. In conclusion, the comparison of the present results with former studies showed a prominent increase for the studied variables, due to the positive improvements in Turkey for five decades.

Janina Tutkuviene, Simona Gervickaite and Dziugile Kersnauskaite discussed the biopsychosocial status of adolescents in the light of socio-economic disasters and the COVID-19 pandemic. The perception of body image is related to biological, psychological, socioeconomic, and cultural factors. Adolescents are particularly sensitive to the effects of these factors. The aim of this study was to analyze global studies related to body image during periods of socioeconomic disasters and pandemics, and to compare the peculiarities of body image of Lithuanian adolescents in pre-pandemic and pandemic periods. Adolescents aged 16–18 years were investigated using the same methodology in two periods: 2015–2019 (pre-pandemic period; n = 278; paper questionnaire) and 2021 (pandemic period; n = 526; online questionnaire). The literature analysis showed a lack of research on body image during socio-economic disasters and pandemics

Table 3 Anthropometric measurements by age and sex.

Boys												
Age (years)	Height (cm)			Forearm Length (cm)			Tibial Length (cm)			Tibio-radial Index		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
6	76	119.01	5.57	76	17.27	1.34	76	25.41	1.81	76	67.83	4.57
7	71	124.75	5.75	71	18.04	1.40	71	26.60	2.17	71	68.01	7.82
8	72	131.53	6.26	72	19.45*	1.49	71	28.70	2.58	71	67.47*	5.31
9	82	136.38	6.82	82	20.23	1.44	82	30.53	2.54	82	66.51	5.03
10	78	141.54	7.37	78	21.18	1.65	78	32.42	2.31	79	65.48	4.59
11	67	147.51	7.85	67	22.32	1.99	67	33.55	2.58	67	66.41	5.03
12	71	155.66	8.57	71	23.66	1.98	71	35.64*	2.54	71	66.42*	3.67
13	41	159.00	9.27	41	24.29	1.92	41	36.20	3.16	41	67.48	5.70
14	36	167.94**	9.36	36	26.11**	1.81	36	39.22**	3.39	36	66.82	4.92
15	58	172.66**	5.10	58	26.49**	1.56	58	38.94**	2.14	57	68.18	4.34
16	77	175.79**	5.95	77	27.22**	2.09	77	39.50**	2.66	77	68.82	5.27
17	41	176.32**	4.83	41	26.70**	1.59	41	39.70**	24.64	32	66.87	5.83
Girls												
Age (years)	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
6	70	117.25	5.5	70	17.1	1.86	70	25.01	1.87	70	68.42	5.82
7	58	124.13	5.72	58	17.97	1.34	58	26.73	1.92	58	67.34	4.05
8	50	130.20	6.92	50	18.84	1.45	50	28.81	2.96	50	65.68	4.94
9	50	137.02	5.56	50	20.00	1.54	49	30.20	1.85	50	66.67	5.08
10	49	141.20	6.89	49	21.00	1.76	49	31.96	2.53	49	65.86	4.62
11	69	148.98	7.59	69	22.36	1.71	69	33.52	2.30	69	66.83	4.70
12	53	153.84	6.22	53	23.48	1.46	53	34.59	1.86	53	67.93	3.62
13	40	157.91	6.54	40	24.50	1.73	40	35.33	2.11	40	69.47	4.87
14	60	161.04	5.65	60	24.36	1.55	60	35.85	2.00	60	68.00	3.26
15	107	161.63	5.67	107	24.27	1.63	107	36.19	2.51	107	67.04	4.69
16	86	161.98	5.73	86	24.37	1.89	86	35.95	2.32	86	67.89	4.92
17	32	162.28	6.14	32	24.14	1.84	32	37.02	2.58	31	65.35	5.00

Student t-test between sexes, *p<0.05, **p<0.001

(only a few studies have focused on adolescent's body image), although more and more research is being conducted during the COVID-19 pandemic (Aparicio-Martinez et al. 2019; Grogan 2021; Hartman-Munick et al. 2020). However, studies differ in methodology; body image definitions vary from study to study. With a few exceptions, components of body image (perception of body size and shape, body dissatisfaction) and self-esteem deteriorated particularly during COVID-19, especially among women and younger people. The changes in the body image of Lithuanian adolescents during the COVID-19 pandemic were as follows: 1) During the COVID-19 pandemic, despite an increase in BMI (especially in adolescent girls), a larger body began to be considered optimal: in girls/boys aged 16–18 years – from

3.3/4,1 to 3.8/4,5 respectively ($p < 0.001$) and girls/boys aged in 19—20 years – from 3.6/4.4 to 3.9/4.7 respectively ($p < 0.01$); however, an increase in the number of girls and boys who were afraid of gaining weight was detected. 2) Self-assessment of various parts of the body and face was the worst in 2021. 3) In both periods (especially in 2021), of the three characteristics (body, character, different abilities), adolescents most wanted to change their body (to achieve a slimmer and more muscular figure). 4) The self-esteem of adolescents (especially older ones) increased during COVID-19, despite a poorer assessment of their overall appearance in 2021. Self-esteem did not depend on BMI. However, adolescents with a higher BMI rated their body worse than other respondents. Thus, it can be concluded that body perception, body dissatisfaction, and self-esteem are not always directly interrelated components.

Arup Ratan Bandyopadhyay presented a short overview on Anthropology in Kolkata, India, since 1921, with research in both natural and social sciences. He gave a brief description regarding the attempts of his team on the issues of biological anthropology and social-cultural anthropology.

Sławomir Kozieł presented a study on the social mobility of fathers and the BMI of their children. Social mobility occurs in socially stratified societies and involves a vertical (up or down) shift of a person's position on a scale of attained education or wealth or power or prestige. Vertical mobility may also occur between generations, where the shift is measured relative to the position of the subject's parents or within a single generation, when the subject moves up or down the scale during his/her adult lifetime. Social status and mobility have significant indirect impact on a society's biological well-being and health status. Previous research (Koziel et al. 2019) indicated that upward social mobility depending on education, results in taller stature, and tends to persist into the third generation. The present study extends this research and adds the effects of social mobility and education on BMI. In order to study social mobility, four mobility patterns were defined, based on social position of the grandfathers (worker versus professional), and education of the fathers (basic or vocational versus secondary or university):

- GP- to P- "Low" SES no changes
- GP- to P+ upward
- GP+ to P- downward
- GP+ to P+ "High" SES no changes

where:

- GP- grandfather occupation – worker;
- GP+ grandfather occupation – professional;
- P- father education basic or vocational;
- P+ father education – secondary or university.

Social mobility prompts effects on height and similar effects on BMI. Figure 2 illustrates mean height and BMI z-scores of boys and girls of the different transition groups. Children whose grandfathers were workers and whose fathers had basic or vocational education ("Low" SES no change) were short, with z-scores close to -0.2 and slim. Children whose grandfathers were workers, but fathers had secondary or university education (upward transition) were significantly taller and heavier. Children whose grandfathers had a professional occupation, and whose fathers had secondary education ("High" SES no changes), were tallest and fattest. Children whose grandfathers had a professional occupation, but whose fathers had only basic or vocational education (downward transition) were short and slim. The social gradients appeared more pronounced in boys.

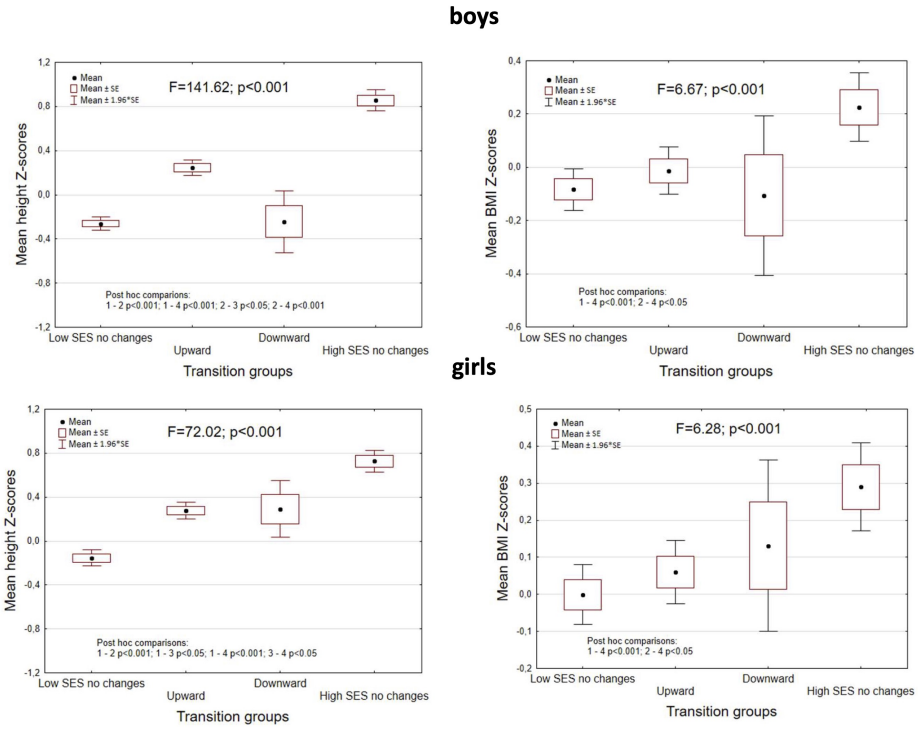

Figure 2 The effects of social mobility on z-scores for height and BMI, in the four transition groups of boys and girls. Children whose grandfathers were workers and fathers had basic or vocational education ("Low" SES no change) were short and slim. Children whose grandfathers were workers, but fathers had secondary or university education (upward transition) were taller and heavier. Children whose grandfathers had a professional occupation, and fathers had secondary education ("High" SES no changes), were tallest and fattest. Children whose grandfathers had a professional occupation, but fathers had only basic or vocational education (downward transition), were short and slim.

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