Journal of Biosocial Science (2022), 54: 2, 347–353
doi:10.1017/S0021932021000067

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Reducing socioeconomic differences in anthropometric characteristics among young Polish women

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(Received 14 January 2020; revised 20 November 2020; accepted 20 November 2020; first published online 15 February 2021)

Abstract

The aim of this paper was to evaluate the socioeconomic differences in adult anthropometric parameters of young women in Poland. The study was cross-sectional and conducted in the years 2015 to 2018 among 1257 women aged 19–24 years. The heights, weights, wrist widths and waist, hip and chest circumferences of the subjects were measured. Body mass index (BMI), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), waist-to-chest ratio (WCR) and chest-to-height ratio (CHtR) were calculated. A survey was conducted to collect data on the women's socioeconomic characteristics. The application of the Generalized Linear Model (GLM) including all socioeconomic indicators (urbanization level of place of residence in childhood, parental education, number of siblings, material conditions) revealed no significant association of these with any of the analysed anthropometric traits. The results of the logistic regression showed no significant differences in the risk of underweight, too low abdominal adiposity or too high abdominal adiposity. However, the risk of overweight and obesity was significantly affected by the degree of urbanization of the women's place of residence in childhood and by their number of siblings. The results show that the socioeconomic factors that once had a significant influence on anthropometric traits currently do not play such an important role. This change can be explained by the equalization of living conditions and lifestyles of individual social groups in Poland.

Keywords: Anthropometric parameters; Body proportion; Socioeconomic status

Introduction

Human body size and shape, despite being genetically determined, are also sensitive to environmental conditions (Ulijaszek, 1995). Currently it is held that socioeconomic status may be one of the most significant environmental modifiers of biological development. The influence of socioeconomic factors on anthropometric traits has been demonstrated in multiple studies based on historical and contemporary data from developed as well as developing countries (e.g. Silventoinen, 1999; Alter *et al.*, 2004; McLaren, 2007; Due *et al.*, 2009; Subramanian *et al.*, 2011).

Differences in the pattern of biological development across social groups result from long-lasting differences in living conditions and lifestyles. These include financial resources, sanitary conditions, hygiene, access to medical care, children's nutrition and children's physical activity, including the degree to which individuals are encumbered with manual labour. Nevertheless, data obtained in studies since the 1990s until the present suggest that living conditions and lifestyles are gradually becoming more and more uniform as a result of social policy programmes and improvements in health care over many years, both in Poland and other European countries, which have led to decreasing socioeconomic differences in biological development (Brundtland *et al.*, 1980; Cernerud *et al.*, 1994; Marrodan *et al.*, 2000; Larnkjær *et al.*, 2006; Kozieł *et al.*, 2014). Over the

past 30 years Poland has undergone profound social, economic and cultural changes that have had an impact on the living conditions and lifestyles of all social classes. It therefore seems justified to verify whether socioeconomic gradients in biological development are still present in Poland.

The aim of this paper was to evaluate the influence of socioeconomic factors on adult anthropometric parameters of young women in Poland. Analysed traits included features developing during various ontogenetic periods. Body height, wrist width and chest circumference can be regarded as cumulative indicators of living conditions over the entire period of progressive development, whereas body weight, waist and hip circumferences, along with related ratios, are considered indicators of current living conditions and lifestyles. It is hypothesized that at present socioeconomic status does not differentiate the anthropometric characteristics of young Polish women.

Methods

The study was cross-sectional and conducted in the years 2015 to 2018. The collected material included both somatometric and survey data. Subjects included students at universities in several Polish cities: Kraków, Kielce, Łódź, Warsaw, Wrocław, Rzeszów and Szczecin. The analysis covered data collected from 1257 women. Women who came from countries other than Poland and those who suffered from chronic conditions other than allergies were excluded from the study.

All subjects were born in the years 1994–1998. At the time the study, the students were 19 to 24 years old. Height, body weight and waist, hip and chest circumferences, as well as wrist width, of the subjects were measured. All measurements were collected according to currently applicable anthropometric study procedures. Height (Ht) measurements were taken by means of an anthropometer accurate to 0.1 cm. Body weight was measured to an accuracy of 0.1 kg. Hip, chest and waist circumferences were measured with a flexible measuring tape accurate to 0.1 cm. Chest circumference (CC) measurement was taken on the xiphoidale level in resting position. Waist circumference (WC) was measured halfway between the costal margin and the iliac crest. Hip circumference (HC) was measured at the level of the widest girth below the wings of ilia. Right and left wrist width measurements were made between the supracarpale radiale and supracarpale ulnare points using electronic callipers accurate to 0.01 mm, and the average of both measurements was used in the analyses. Next, body mass index (BMI), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), waist-to-chest ratio (WCR) and chest-to-height ratio (CHtR) were calculated.

Socioeconomic status was determined on the basis of variables considered reliable indicators of living conditions and lifestyle in Poland and Europe: degree of urbanization of the place of residence, parental educational attainment, number of children in the family and its financial status. The division of factors into categories and the percentage of subjects representing a given category was as follows: for the place of residence before leaving for university (place of residence in childhood): village (37.23%), town up to 100,000 inhabitants (33.02%), city above 100,000 inhabitants (29.75%); for mother's and father's educational attainment: vocational (mother's – 21.74%, father's – 38.35%), secondary (mother's – 29.94%, father's – 28.00%), higher (mother's – 48.32%, father's – 33.65%); for number of siblings: none (15.51%), one (46.86%), two (23.87%), three or more (13.76%); for self-assessed financial situation: very good (16.07%), good (51.63%), average (27.53%), modest, varying or hard to specify (4.77%).

Statistical analyses were performed with the use of statistical software suite Statistica version 13.0 (StatSoft Polska). The Generalized Linear Model (GLM) method was used to evaluate the effect of socioeconomic factors on anthropometric traits. The Variance Inflation Factor (VIF) was used to detect the severity of multicollinearity. The VIF for predictive factors in the GLM method ranged between 1.29 and 2.69. Because none of the independent variables included in the study had a high VIF (>5), they were all included in the model. Logistic regression was used to assess a risk of underweight, overweight, too low abdominal adiposity and too high abdominal adiposity. Bonferroni corrections were employed to reduce Type I errors when multiple tests or comparisons were conducted. Significance in all statistical tests was set at the level of $p<0.05$.

https://doi.org/10.1017/S0021932021000067 Published online by Cambridge University Press

Table 1. Anthropometric characteristics of subjects

	Mean	SD	Median
Height (Ht) [cm]	165.3	5.80	165.20
Chest circumference (CC) [cm]	74.1	6.46	73.00
Waist circumference (WC) [cm]	72.7	8.34	71.00
Hip circumference (HC) [cm]	97.4	7.26	97.00
Wrist width [mm]	50.99	2.82	50.96
BMI	22.45	3.40	21.85
WHR	0.75	0.05	0.73
WHtR	0.44	0.05	0.42
WCR	0.98	0.06	0.97
CHtR	44.89	3.94	44.23

Results

Table 1 presents the anthropometric characteristics of the study subjects. The Shapiro-Wilk test revealed that the distribution did not deviate from normal in the case of height, while other traits such as chest, waist and hip circumferences, as well as the ratios such as BMI, WHR, WHtR, WCR and CHtR, were characterized by skewed distributions (Table 1). Deviation from a normal distribution was nevertheless slight, as confirmed by skewness ratios, which did not fall below –1.5 or exceed 1.5 (George & Mallery, 2010). Cook's distance measures were applied to identify outliers. Next, the Box-Cox test was used to determine whether the dependent variables needed any transformation in order to have a symmetric distribution. The test results showed that the linear, log and multiplicative inverse specifications were all strongly rejected.

Due to the fact that linear regression analysis is very sensitive to outliers, the analysed data were checked for the presence of outlying values. In this study, outliers were defined as values that differed from the mean by more than three standard deviations. The presence of outliers was reported both for BMI and WC. For those traits, models including and excluding those cases were created to verify whether or not their presence distorted the results, and the analyses demonstrated that the presence of outliers did not influence the results.

The results suggest the disappearance of socioeconomic differences in anthropometric parameters (height, wrist width, waist circumference, hip circumference and chest circumference) and body proportions (BMI, WHtR, WHR, WCR and CHtR). The application of the Generalized Linear Model (GLM), which included all socioeconomic indicators, did not reveal a significant effect on any of the analysed anthropometric parameters (F varied from 0.09 to 2.59; p-values varied from 0.08 to 0.97). The R^2 values show that the applied model provides for only a small percentage of the variability of body size parameters (0.49–4.21%) and proportions (0.53–1.46%).

In addition, the risks of underweight, overweight, too low abdominal adiposity and too high abdominal adiposity were assessed. The logistic regression model was used. The results showed that none of the socioeconomic factors affected the risk of underweight (BMI$<$18.5). The risk of overweight and obesity was significantly affected by the degree of urbanization of the place of residence and the number of siblings. Females from rural areas and large families had the lowest likelihood of excessive weight (Table 2). No effect of socioeconomic factors on the risk of abdominal obesity, determined using different indicators (WC$>$80 cm, WHR$>$0.80, WHtR$\geq$0.5) or too low level of abdominal adiposity (WHtR$<$0.4), was found.

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Table 2. Risk of overweight (BMI≥25) of subjects by socioeconomic factors

		OR	95%CI
Place of residence in childhood	Village	0.60	0.42–0.86
	Town	0.85	0.60–1.20
	City (Ref.)		
		$p = 0.018$	
Mother's education	Vocational	1.11	0.67–1.83
	Secondary	1.19	0.76–1.87
	Higher (Ref.)		
		ns	
Father's education	Vocational	0.91	0.57–1.44
	Secondary	0.92	0.56–1.51
	Higher (Ref.)		
		ns	
Number of siblings	0 (Ref.)		
	1	0.87	0.43–1.79
	2	0.55	0.28–1.09
	3+	0.56	0.37–0.89
		$p = 0.008$	
Material conditions	Modest	0.86	0.33–2.23
	Average	0.79	0.45–1.39
	Good	0.69	0.41–1.16
	Very good (Ref.)		
		ns	

Discussion

The results of this study demonstrate that socioeconomic status in Poland is no longer a factor diversifying anthropometric traits. The disappearance of socioeconomic differences can be explained by the equalization of living conditions and lifestyles of individual social groups.

Generally speaking, the social transformation taking place in many countries may be interpreted as a gradual propagation of features of high social status. The main cause of this process is that such groups are becoming more numerous. The number of people with higher education is on the rise, while the number of low-qualified blue-collar workers is decreasing. Thanks to easy access to information and a general increase in wealth, many components of the lifestyle typical of groups of higher socioeconomic status also permeate lower social strata. As a result of those changes, children from families of lower socioeconomic status are catching up with those from higher strata in terms of development (Bielicki, 1998). Auxologists claim that after reaching a certain high average standard of living, differences in living conditions and lifestyles between socioeconomic groups will no longer affect biological development. Still, the level must be high enough so as to ensure optimum development conditions, even for the lowest social groups (Tanner, 1987). Such a situation is possible either due to a very high minimum salary or state support for the poorest families. This is the reason why first reports on the disappearance of socioeconomic gaps in biological development came from countries with elaborate social policy

https://doi.org/10.1017/S0021932021000067 Published online by Cambridge University Press

systems such as Sweden and Norway (Lindgren, 1976; Listōl & Rosenberg 1995). In the final decade of the 20th century a significant reduction of socioeconomic differences in biological condition was also reported in highly developed countries such as the United Kingdom and Hong Kong (Leung *et al.*, 1996; Li *et al.*, 2004; Krzyżanowska & Mascie-Taylor, 2011).

Over the past 20 years the economic situation of households in Poland has seen a systematic improvement. An elaborate social welfare system also ensures appropriate conditions for child development, even in the lowest social groups, leading to the decreasing of differences in the rate of development and body dimensions across social groups. In addition, children and adolescents are spending more and more time in total in educational institutions such as crèches, kindergartens and schools. In such places they eat meals and participate in additional activities, which also contributes to growing uniformity of their lifestyles and may result in the disappearance of biological differences related to socioeconomic status (Wronka & Pawlińska-Chmara, 2009).

Another explanation for the disappearance of socioeconomic differences is linked to the hypothesis of environmental adversity formulated by Harrison and Schmitt (1989), according to which increasing wealth and improvements in average living conditions should be related to a reduction in socioeconomic – and consequently biological – differences between groups of various status. Although the hypothesis has been positively verified in multiple studies (Komlos, 1990; Silventoinen *et al.*, 1999; Hermanussen *et al.*, 2014), the relationship is not noticeable in all age groups (Ipsen *et al.*, 2016; Mumm *et al.*, 2016), and Polish data do not seem to fully confirm it (Nowak-Szczepanska *et al.*, 2016).

Another hypothesis for the equalization of development in individuals from various social groups is the community effect hypothesis (Hermanussen *et al.*, 2014). This hypothesis is based on studies that showed that a person's height in adulthood 'adjusts' to mean stature in a given community (Aßmann & Hermanussen, 2013). This is particularly noticeable in immigrants' children, whose development corresponds more to children from the country in which they currently live than those in their parents' country of origin (Bogin *et al.*, 2018). The phenomenon is explained by the leading role of the growth hormone (GH), which triggers the secretion of an insulin-like growth factor (IGF-1). The GH/IGF-1 axis converts various environmental factors into a consistent signal which allows individuals to adapt to local environmental conditions (Bogin *et al.*, 2015).

A study published in the scientific literature also indicates that because many cooperative mammals, including humans, have a social position related to their age and body size, the rate of their growth is modified by competitive strategies. Individuals may adjust their growth to the size of their closest competitor and the optimal growth is like that of other peers (Huchard *et al.*, 2016).

This study is limited in that its subjects included female students only. It should be emphasized that the tests were conducted both in small local universities as well as large academic centres. The present situation in Poland is conducive to studying at a university; in fact, never before have so many people studied in Poland. The reform of education, related to the significant reduction in the number of vocational schools, creation of a large number of high schools, in both large and small cities, and the labour market situation with its lack of employment for high school graduates, have caused the trend of widespread academic education. Currently, Poland has one of the highest rates of university students among EU countries (GUS – Statistics Poland, 2019). Consequently, study subjects came from different backgrounds in terms of socioeconomic status. However, the analysed group did not feature poor individuals or persons living on the poverty line. It is also worth noting that results of university studies carried out among Polish students in previous decades revealed statistically significant differences in anthropometric measurements depending on socioeconomic factors and that in those periods university students were a more select group than today (Kolasa, 1980; Malinowski & Jeziorek, 1992; Jopkiewicz & Zabrodzka, 1997; Charzewska *et al.*, 2004; Wronka & Pawlinska-Chmara, 2009; Krzyżanowska & Umławska, 2010; Wronka *et al.*, 2012).

https://doi.org/10.1017/S0021932021000067 Published online by Cambridge University Press

A strength of the study is that the subjects were of similar age, i.e. in early adulthood. This allowed changes arising from secular trends to be excluded. In the case of intense changes in environment, trends are visible not only across consecutive generations, but already when comparing cohorts whose date of birth differs by 5 to 10 years (Charzewska *et al.*, 2004; Saczuk *et al.*, 2018). As all subjects were past the adolescence period, it was possible to evaluate the effect of environmental factors on their body dimensions in adulthood. When analysing data from younger persons there is no certainty that differences between groups from varying backgrounds will increase, decrease or disappear with age. Literature on the subject contains data which confirm that intra-population diversification of phenotypic traits depends on subjects' age and is structured differently in early childhood than during adolescence (Redžić & Hadžihalilović, 2007).

In summary, the results of this study, as well as reports of other researchers, suggest that the factors that once had significant influence on anthropometric traits currently do not play such an important role. This indicates the need to constantly monitor the determinants of biological development. In future research it would be advisable to verify the relationship between lifestyle (in particular nutritional habits, health-seeking behaviour and exercise) and socioeconomic status, using both currently used and novel status indicators. This would allow determination of which groups have the greatest exposure to developmental and health problems.

Funding. This research received no specific grant from any funding agency, commercial entity or not-for-profit organization.

Conflicts of Interest. The authors have no conflicts of interest to declare.

Ethical Approval. The study was approved in advance by the Bioethics Committee of Jagiellonian University. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on the human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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Cite this article: Kliś K and Wronka I (2022). Reducing socioeconomic differences in anthropometric characteristics among young Polish women. *Journal of Biosocial Science* **54**, 347–353. https://doi.org/10.1017/S0021932021000067