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## THE SECULAR TREND IN BODY HEIGHT IN THE RURAL POPULATION OF PODBEREZCE (UKRAINE), IN THE 19th AND 20th CENTURIES

**ABSTRACT:** Differentiation of populations by mean body height reflects actual living conditions of an individual and a group, and the analysis of these changes in time allows to explore possible modifications of the living conditions and to identify the time and directions of long-term trends in changes within this trait. The aim of the paper is to present the secular trend in body height in the rural population of Podberezce (Ukraine) and a potential effect of differential mortality on the mean value of this trait in the population. The research material comprises the data kept in the archives of the Institute of Anthropology in Poznań, Poland. It includes research sheets for 106 males and 95 females, containing anthropometric data. The data were analyzed in three cohorts born in the years: 1850–1879, 1880–1899 and 1900–1918. The secular trend in body height manifested as the increase of mean body height in males by 4.6 cm and in females by 4.0 cm. No correlation was found between the number of sibling deaths in the families of the subjects, and the mean body height in cohorts. This result corroborates the thesis of, in a sense, independent realization of the two biological potentials: the reproductive potential and the growth potential in the population, which are determined by different sets of modifying factors.

**KEY WORDS:** Mean body height – Rural population – Secular changes – Ukraine

### INTRODUCTION

Body height is recognized as one of the most sensitive measures used in the study of interactions between the biological structure of human communities and physical and biocultural factors of the living environment (Johnston 1995, Steckel 1995, Nicoletti *et al.* 1996, Bielicki *et al.* 1997). Differentiation of populations by mean body height reflects actual living conditions of an individual and a group, and the analysis of these changes in time allows to explore possible modifications of the living conditions and to identify the time and directions of long-term trends in changes within this trait (Eveleth, Tanner 1990, Hermanussen *et al.* 1995, Ulijaszek *et al.* 1998). Since the mid 19th century a positive secular trend in body height has been observed in almost all countries of Europe, North America and Japan. Among the complexes of environmental factors having an effect on the occurrence of the secular trend the most important one is a broadly understood nutrition and health status of the population. Indirect factors, which fall within the scope of these complexes, include changes in socioeconomic living conditions, welfare and health care, level of income, quality of food, sanitary conditions, mass character of vaccination and level of education (Bielicki *et al.* 1982, Van Wieringen 1986, Tanner 1992, Hauspie *et al.* 1996, Bodzsár, Susanne 1998, Bielicki, Szklarska 1999).

Living conditions have a stronger effect on individuals with poorer, genetically conditioned health; and a weaker effect on better adapted individuals capable of maintaining internal homeostasis under a wider range of living conditions. Therefore, a poorer development and lower body height may be a cause of increased mortality in a given population. Stronger negative selection limits the number of individuals who are short due to impaired development. Mean body height, however, depends not

only on living conditions but also on the strength of selective pressure affecting mortality differentiated according to adaptation (Wolański, Kasprzak 1976, Wolański 1985, Fogel *et al.* 1982, Jury nec 1986, Tanner 1986, Sobral 1990). The studies of modern populations show that body height may also be a predictor of mortality due to civilization-related illnesses such as coronary heart disease (Waller 1984, Barker *et al.* 1990). At the same time the secular trend in body height observed in the developed European countries seems to be much more distinct among lower social classes than among higher social classes. Moreover, in some populations, the body height of adult individuals has reached a certain limit value, which may suggest that the groups have reached the maximum realization of their own genetic potential or that socioeconomic conditions have ceased to improve (Łaska-Mierzejewska *et al.* 1982, Bielicki *et al.* 1997, Padez 2003).

It seems important to use historical sources and data gathered at the turn of the 19th and 20th centuries in anthropological studies, especially when the materials contain biological and demographic characteristics of groups with different levels of technological and organizational development. Drawing on sources of this type, the dynamics of a secular trend in body height in local populations can be shown.

The aim of this paper is to present the dynamics of the secular trend in body height and a potential effect of differential mortality on the mean value of this trait in the population.

### MATERIAL AND METHODS

In 1937–1938 Wokroj conducted anthropological field studies among the Ukrainian population of Podberezce, a village situated in Lviv district.

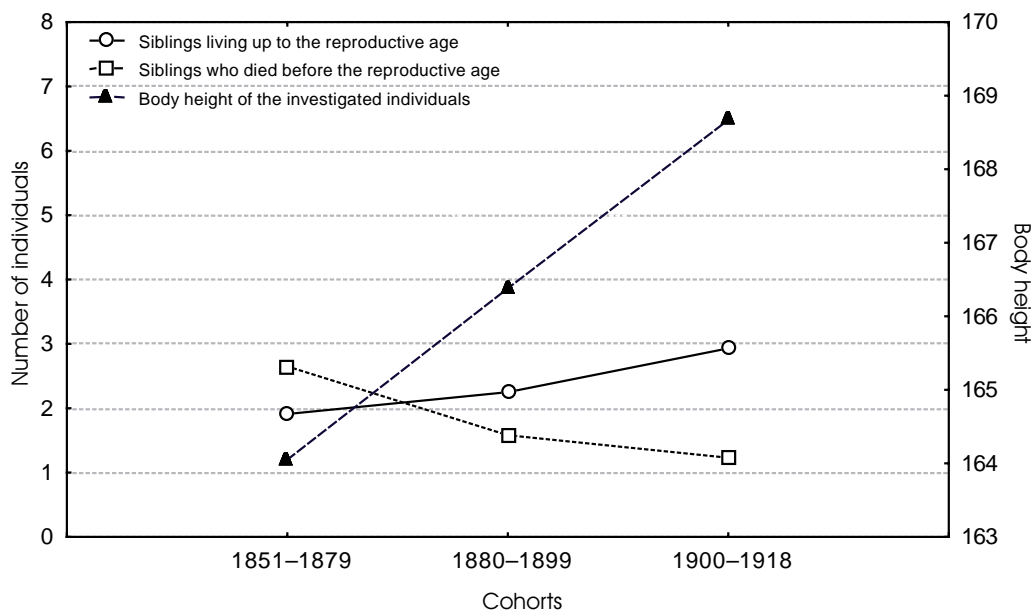


FIGURE 1. Arithmetical means of demographic data concerning the investigated families and body height for the investigated individuals in cohorts (males).

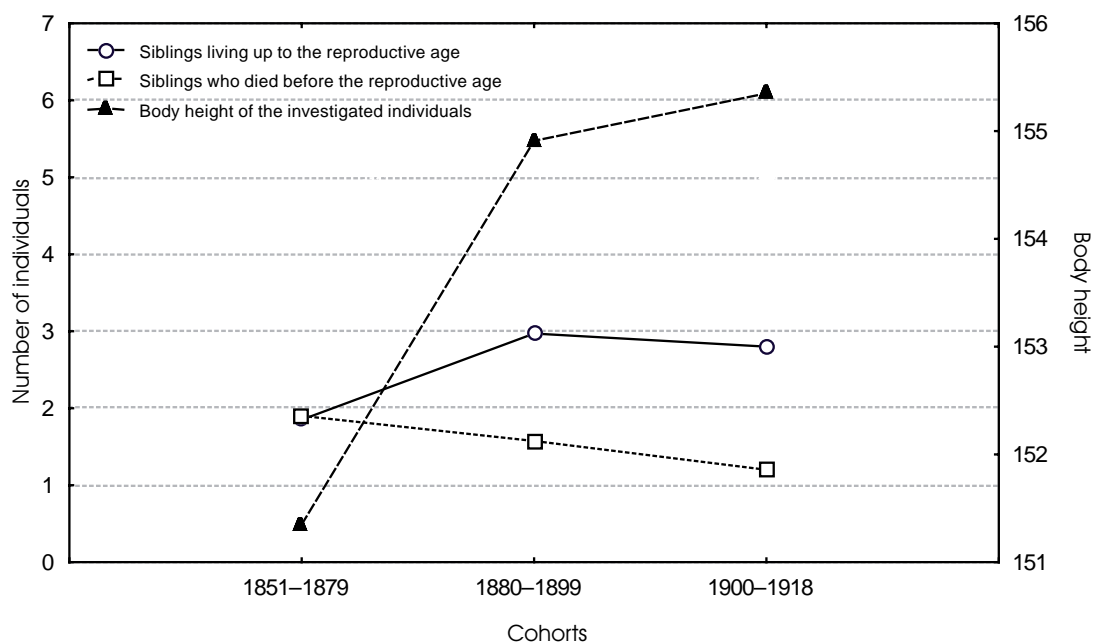


FIGURE 2. Arithmetical means of demographic data concerning the investigated families and body height for the investigated individuals in cohorts (females).

The village of Podberezce is situated 14 km from Lviv, by the Lviv to Zloczow route. It is an old settlement, founded under the Teutonic (Magdeburg) law. The first written mention of Podberezce is dated back to 1454. Its inhabitants, mainly of Greek Orthodox persuasion, belonged to the wealthiest in the area. Anthropological research results show that they were well-built and well-nourished. They were mostly farmers and artisans selling their products in Lviv and its suburbs. Also the fact that a high proportion of young people from the village studied at universities in Lviv and abroad indicates the prosperity of the population (Wokroj 1948).

In the 1930s the settlement attracted attention of medical circles due to a high incidence of tuberculosis (approx. 30%) in the community, despite its relatively good material, geographic and climatic conditions. The then Institute of Anthropology of the Lviv University was asked to

carry out anthropological research in the population in order to investigate its potential predisposition to the disease. The research results, in the form of research records, currently kept at the Institute of Anthropology of the Adam Mickiewicz University in Poznań, served as a basis for this publication.

The data from the records formed a database which was subsequently a source of information on individuals with accurately documented life history, born between 1850 and 1918 (106 males, 95 females). The subjects were aged from 18 to 85 years. The study material has been divided into three cohorts of individuals born between: 1850 to 1879, 1880 to 1899, 1900 to 1918.

Mean values and standard deviations of body height of the men and women under study were calculated for individual cohorts. The authors

computed also Spearman's coefficient of rank correlation between mortality of children in the family and body height of the subjects. The data were processed using Excel 7.0 calculation spreadsheet and Statistica 5.1 package.

**RESULTS**

An analysis of the mean body height of subjects in cohorts (*Table 1*) indicates a clear secular trend in this trait in the population under study. Mean body height of females in the first cohort was 151.4 cm, while for women born between 1900 and 1918 it was 155.4 cm. The mean increment in the whole period under study amounts to 4 cm, i.e. 0.8 cm per decade. For men the results are as follows: the mean increment in 1850-1900 was 4.6 cm, which makes a 0.92 cm increase per decade. Simultaneously, we observe a considerable differentiation in the dynamics of the trend between cohorts of both sexes. In women there is a distinctly higher increase in body height between the first and the second cohort,

while in men there is a fairly stable growth trend over the entire studied period.

*Figures 1 and 2* represent mean values of body height and demographic data concerning the investigated families, in men and women in cohorts. Mortality of siblings of subjects was gradually decreasing. It seems justified to ask the question whether a smaller size of family resulted in improving its socioeconomic conditions to such a degree that this could have had an effect on the offspring's growth dynamics and be conducive to a trend towards body height increase. Or perhaps these are mutually independent phenomena in which a certain part of the population's biological potential, having no relation to the realization of the ontogenetic pattern of growth expressed in the body height reached, is realized through fertility and mortality.

Rank correlations between subjects' body height and the number of deceased siblings were examined using Spearman's method. Results of this analysis are shown in *Tables 2 and 3*. No relationship was found between the examined variables in any of the cohorts (in both men and women).

TABLE 1. Mean body height of the investigated individuals and standard deviations in cohorts.

Cohorts	Males			Females		
	N	Mean	SD	N	Mean	SD
1850-1879	23	164.1	6.2	18	151.4	6.3
1880-1899	24	166.4	5.1	27	154.9	4.0
1900-1918	59	168.7	6.0	50	155.4	4.8

TABLE 2. Spearman's rang correlation between body height of the investigated individuals and the number of siblings who died in cohorts - males.

Cohorts	N	R Spearman	t(N-2)	p
1850-1879	23	-0.04	-0.21	0.82
1880-1899	24	-0.11	-0.52	0.60
1900-1918	59	-0.04	-0.35	0.72

TABLE 3. Spearman's rang correlation between body height of the investigated individuals and the number of siblings who died in cohorts - females.

Cohorts	N	R Spearman	t(N-2)	p
1850-1879	18	0.14	0.60	0.55
1880-1899	27	0.13	0.70	0.48
1900-1918	50	-0.23	-1.65	0.10

TABLE 4. Mean body height for males in the investigated population and in the comparative groups.

Populations	Year	Mean height	Author
Podberezce	1850-1918	166.4	own data
American conscripts	1860	174.1	A'Hearn 1998
American slaves	1860	168.7	Komlos, Baten 1998
Bavaria	1860	167.3	Baten, Murray 2000
Ukrainian conscripts	1883	166.7	Krzywicki 1912
Podolian conscripts	1883	166.6	Krzywicki 1912

TABLE 5. Mean body height for females in the investigated population and in the comparative groups.

Populations	Year	Mean height	Author
Podberezce	1850-1918	153.9	own data
Females from Ukraina	1883	154.8	Talko-Hryncewicz 1894
Females from Lithuania	1883	153.6	Talko-Hryncewicz 1894
Females from Podlasie	1890	150.7	Krzywicki 1912
Countrywomen from Lublin guberniya	1890	152.0	Krzywicki 1912
Townwomen from Lublin guberniya	1890	153.0	Krzywicki 1912

## DISCUSSION

Tables 4 and 5 show the mean body height of individuals from the Podbereze population against the results for comparative groups from the literature. Unfortunately, the literature on the studies carried out in the 19th and the mid-20th century offers usually information on the values of the trait in men, as they were taken from conscripts' and soldiers' measurement records. Hence, the different comparative data sets for men and women, though we chose them according to their temporal proximity to the period of origin of the data we had at our disposal.

Both men and women from the Podbereze population proved to have mean body height values similar to groups close to them in time and geographic location. Such results could be expected, considering such groups were likely to have a similar genetic outfit, similar level of socioeconomic development and live under a similar set of environmental factors modifying the growth process and affecting the ultimate body height reached by individuals.

The result of an analysis of the relationship between the mean body height of individuals in cohorts and the number of their siblings who had died before reaching sexual maturity proved to be negative. Spearman's rank correlation showed no relationship between these variables. A similar analytical attempt was taken in a study by Jurynek (1986). The research material included soldiers born in Poland between 1899 and 1901. The author adopted a thesis that if short individuals under certain environmental conditions turn out to be less adapted and are thus characterized by higher mortality, this environmental impact may then lead to an increase of the mean body height in the population. The results obtained, however, failed to corroborate the thesis. The number of the surviving siblings of the subjects proved to have no relationship to body height. Little *et al.* (1989) studied the relationship between fertility and mortality, and body height in the south Mexican Zapotec tribe. The authors decided to find out whether the small body height observed in that population is a result of the impact of the specific environmental factors, or whether it is genetically conditioned. They found no relationship between the natural movement components, and body height of the subjects. Therefore, they concluded that small (in this case) body height is an effect of environmental factors, rather than of genetic determination and thus opportunity for natural selection is not realized through impact on or correlation with body height.

As we know, the ultimate body height reached by an individual is an effect of a combination of genetic and environmental factors. In modern, post-industrial communities approximately 20% of body height differences are due to environmental factors. In indigent societies the proportion is likely to be higher (Silventoinen 2003). Broadly understood socioeconomic factors, however, do not have a direct influence on individuals' body height, but they affect a human body through elements such as adequate nutrition or health care. Small body height is usually related with low social position and low level of education, which in turn is related to the family environment in which the individual's growth was taking place (Sandberg, Steckel 1987, Floud 1994, Bielicki, Szklarska 1999). Body height reached by an individual as an adult can be treated as a kind of measure of living conditions during childhood, which is true of developing countries but also of modern highly developed societies.

Changes in the pattern of growth have been observed over a number of years in a variety of human populations. Particularly interesting are studies on populations considerably distinct in terms of living conditions or the level of technological and organizational development. Studies involving conscript soldiers offer a chance to observe changes in the somatic development of young males over a long period of time (Jaeger *et al.* 2001). For instance, the results of the body height study of German conscripts indicate a stable increase in the trait's value since 1957. At the same time a clear differentiation is noted between eastern and western regions of Germany. Here, again we have to do with a strong influence of socioeconomic conditions on body height. In the studied population from Podbereze we observed a secular trend in body height. The increment amounted to 0.8 cm per decade in women and 0.92 cm per decade in men. With no doubt, the increase resulted from the positive changes which took place between 1850 and 1900, involving improvements in the nutrition pattern, better health care, economic advancement and a

general betterment of the population's living conditions. One should add that the village of Podbereze is situated in a close vicinity of Lviv and the positive changes taking place in the rural environment were no doubt an indirect effect of the region's urbanization.

## CONCLUSIONS

1. Both males and females from the studied population turned out to be similar in terms of mean body height to other populations close to them in temporal and geographical sense. This is likely to be due to a similar genetic outfit, level of socioeconomic development and set of environmental factors which were modifying the process of growth and had an effect on the ultimate body height in these populations.

2. The secular trend in body height was not caused by a decline in opportunity for natural selection. New economic and cultural conditions in the wake of the industrial revolution in Central Europe in the latter half of the 19th century shaped new levels of the two indicators of the biological state of the population that were examined.

## REFERENCES

- A'HEARN B., 1998: The antebellum puzzle revisited: A new look at the physical stature of union army recruits during the Civil War. In: J. Komlos, J. Baten (Eds.): *The Biological Standard of Living in Comparative Perspective*. Pp. 250–267. Franz Steiner Verlag, Stuttgart.
- BARKER D. J. P., OSMOND C., GOLDING J., 1990: Height and mortality in the counties of England and Wales. *Annals of Human Biology* 17: 1–6.
- BATEN J., MURRAY J., 2000: Heights of men and women in nineteenth century Bavaria: Economic, nutritional, and disease influences. *Explorations in Economic History* 37: 351–369.
- BIELICKI T., SZCZOTKA H., CHARZEWSKI J., GÓRNY S., 1982: Rozwarstwienie społeczne współczesnej ludności Polski: analiza wysokości ciała poborowych urodzonych w 1957 r. (Social stratification of the modern Polish populace: An analysis of body height of conscripts born in 1957). *Przegląd antropologiczny* 47: 237–259.
- BIELICKI T., SZKLARSKA A., WELON Z., BRAJCZEWSKI CZ., 1997: *Nierówności społeczne w Polsce: antropologiczne badania poborowych w trzydziestoleciu 1965–1995*. (Social stratification in Poland: An analysis of conscripts between 1965 and 1995). Monografie zakładu antropologii PAN we Wrocławiu, vol. 23, Wrocław. 137 pp.
- BIELICKI T., SZKLARSKA A., 1999: Secular trends in stature in Poland: National and social class-specific. *Annals of Human Biology* 26: 251–258.
- BODZSÁR É. B., SUSANNE C., 1998: Patterns of secular change of growth and development. In: É. B. Bodzsár, C. Susanne (Eds.): *Secular Growth Changes in Europe*. Pp. 5. Eotvos University Press, Budapest.
- EVELET P. H., TANNER J. M., 1990: *Worldwide Variation in Human Growth*. Cambridge University Press, Cambridge. 409 pp.
- FLOUOD R., 1994: The heights of Europeans since 1750: A new source for European economic history. In: J. Komlos (Ed.): *Stature, Living Standards, and Economic Development*. Essays in Anthropometric History. Pp. 9–24. University of Chicago Press, Chicago.
- FOGEL R. W., ENGERMAN S. L., TRUSSEL J., 1982: Exploring the uses of data on height: The analysis of long term trends in nutrition, labor welfare and labor productivity. *Social Science History* 6: 401–581.
- HAUSPIE R. C., VERCAUTEREN M., SUSANNE C., 1996: Secular changes in growth. *Hormone Research* 45: 8–17.
- HERMANUSSEN M., BURMEISTER J., BURKHARDT V., 1995: Stature and stature distribution in recent West German and historic samples of Italian and Dutch conscripts. *Amer. J. of Hum. Biology* 7: 507–515.

- JAEGER U., ZELLNER K., KROMEYER-HAUSCHILD K., LUDDE R., EISELE R., HEBEBRAND J., 2001: Body height, body weight and body mass index of German military recruits. Historical retrospect and current status. *Anthropologischer Anzeiger* 59, 3: 251–273.
- JOHNSTON F. E., 1995: Environmental constraints on growth: Extent and significance. In: R. Hauspie, G. Lindgren, F. Falkner (Eds.): *Essays in Auxology*. Pp. 375–386. Castlemead Publisher, Welwyn Garden City.
- JURYNEC R., 1986: Wpływ selekcji negatywnej na średnią wysokość ciała w populacji – ujęcie ekologiczne (The influence of negative selection on stature in populace – An ecological approach). *Przegląd antropologiczny* 52: 113–116.
- KOMLOS J., BATEN J., 1998: *The Biological Standard of Living in Comparative Perspective*. Franz Steiner Verlag, Stuttgart. 526 pp.
- KRZYWICKI L., 1912: Charakterystyka fizyczna ludności ziem polskich i dzielnic ościennych (The physical characteristics of Polish populace and the neighbouring districts). *Encyklopedia Polska* 1: 465–654.
- LITTLE B. B., MALINA R. M., BUSCHANG P. H., LITTLE L. R., 1989: Natural selection is not related to reduced body size in rural subsistence agricultural community in southern Mexico. *Hum. Biol.* 61: 287–296.
- ŁASKA-MIERZEJEWSKA T., MILICER H., PIECHACZEK H., 1982: Age at menarche and its secular trend in urban and rural girls in Poland. *Annals of Human Biology* 9: 227–233.
- NICOLETTI, MILANIS., BOSSIA., 1996: Growth in Italian children. *Bibliotheca. Nutitio et Dieta* 53: 60–73.
- PADEZ C., 2003: Secular trend in stature in the Portuguese population (1904–2000). *Annals of Human Biology* 30, 3: 262–278.
- SANDBERG L. G., STECKEL R. H., 1987: Heights and economic history: The Swedish case. *Annals of Human Biology* 14: 1010–1110.
- SILVENTOINEN K., 2003: Determinants of variation in adult body height. *J. of Biosociological Science* 35, 2: 263–285.
- SOBRAL F., 1990: Secular changes in stature in Southern Portugal between 1930 and 1980 according to conscript data. *Hum. Biol.* 62: 491–504.
- STECKEL R. H., 1995: Stature and standard of living. *J. of Economic Literature* 33: 1903–1940.
- TALKO-HRYNCEWICZ J., 1894: Charakterystyka fizyczna narodów Rusi (The physical characteristics of Ruthenian nations). *Encyklopedia Polska* 1: 465–654.
- TANNER J. M., 1986: Growth as a mirror of the conditions of society: Secular trends and classifications. In: A. Demirjan, M. Braut Dubuc (Eds.): *Human Growth: A Multidisciplinary Review*. Taylor and Francis, London.
- TANNER J. M., 1992: Growth as a measure of the nutritional and hygienic status of population. *Hormone Research* 38: 106–115.
- ULJASZEK S. J., JOHNSTON F. E., PREECE M. A., 1998: *The Cambridge Encyclopedia of Human Growth and Development*. Cambridge University Press, Cambridge. 509 pp.
- VAN WIERINGEN J. C., 1986: Secular growth changes. In: F. Falkner, J. M. Tanner (Eds.): *Human Growth*. Vol. 3. Pp. 307. Plenum: New York.
- WAALER H., 1984: Height, weight and mortality. The Norwegian experience. *Acta Medica Scandinavia* 679: 1–56.
- WOKROJ F., 1948: Ludność ukraińska wsi Podbereżce pod względem antropologicznym (Ukrainian populace in Podbereżce village in respect of anthropology). *Sprawozdania Polskiej akademii umiejętności* 49, 8: 458.
- WOLAŃSKI N., KASPRZAK E., 1976: Niektóre prawidłowości stosunku organizm-środowisko w świetle badań populacji ludzkich (Some regularities of the relationship between an individual and the environment in the light of the studies of human populations). *Seria antropologia (UAM)* 4: 9–17.
- WOLAŃSKI N., 1985: Secular trends, secular changes, or long-term adaptational fluctuations? *Acta Medica Auxologica* 17: 7–19.

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