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BODY HEIGHT AS A MEASURE OF THE STANDARD OF LIVING: EUROPE, AMERICA AND ASIA

The content outline: Body height reflects the standard of living in the first 18–20 years of life, while its changes serve as an index measuring the well-being of the society. Steady growth of body height in the Polish territory started in the 1860s. The changes recorded in earlier periods were reversible: the highest average was noted in Late Middle Ages, with body height then regressing until mid-19th century. The evolution of body height in Japan and Korea is a reflection of genetic and environmental conditions. The Japanese were higher than Koreans in the mid-20th century, but as the level of economic development of both countries became equal, the height of Koreans surpassed the average height of the Japanese. Even more dramatic influence of the environment can be noticed in the comparison of the body height of South and North Koreans over the 20th century.

Zarys treści: Wysokość ciała odzwierciedla poziom życia w pierwszych 18–20 latach życia, a jej zmiany są miernikiem dobrostanu społeczeństwa. Na ziemiach polskich trwały wzrost wysokości ciała rozpoczął się w latach 60. XIX w. Wcześniejsze zmiany były odwracalne: najwyższa średnia przypadła w późnym średniowieczu, po czym do połowy XIX w. miał miejsce regres. Ewolucja wysokości ciała w Japonii i Korei obrazuje uwarunkowania genetyczne i środowiskowe. Japończycy byli wyżsi w połowie XX w., ale po zrównaniu poziomu rozwoju gospodarczego obu krajów, wysokość Koreańczyków przekroczyła średnie japońskie. Jeszcze dramatyczniej wpływ środowiska widać porównując Koreę Południową i Północną na przestrzeni XX w.

Keywords: historical auxology, human ecology, body height, stature, technophysio evolution, secular trend, Poland, Japan, Korea

Słowa kluczowe: auksologia historyczna, ekologia człowieka, wysokość ciała (human stature), technofizjo ewolucja, trend sekularny, Polska, Japonia, Korea

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Preliminary comments

In 1930, in the conclusion of his analysis of changes in the height of army conscripts in the Kingdom of Poland, Jan Czekanowski wrote: "Finally, in light of the results of this work, it is worth mentioning that the documents of local draft boards, which are usually underestimated, should be rated as first-class sources. Anthropologists, sociologists as well as scholars of economic history should request that these documents be published."[1]

Czekanowski may not have been the first Polish scholar to study the issue, but he did draw up a comprehensive research program and identify the sources. Although the majority of the abundant data, collected on the initiative of Czekanowski and Jan Mydlarski in the interwar period, have not survived, research undertaken after the war has enabled outlining the evolution of body height after 1945.[2]

Czekanowski's research program referred to the pioneer work by the French army doctor Louis-René Villermé, who in 1828 published a study on the mortality and body height of the inhabitants of rich and poor districts of Paris, and a year later – an analysis of conscripts in the years 1812–1827. He concluded this last study by stating: "Increased body height and a faster pace of growth depends, *ceteris paribus*, on a country's wealth, way of life, quality of the dwellings, clothing, diet, type of work, manner and conditions in which a person was raised in their early childhood. In other words, poverty and deprivation delay the moment of attaining adult height, at the same time they have an impact on the reduction in ultimate body measurements."[3] Villermé's opinion does not digress greatly from the contemporary approach according to which "each person is attributed a maximum theoretically achievable limit of body height which depends exclusively on the individual's genotype. This limit is the maximum body height

[1] J. Czekanowski, *Zarys antropologii Polski*, Lwów 1930, pp. 136–137.

[2] T. Bielicki, T. Krupiński, J. Strzałko, "Historia antropologii w Polsce", *Przegląd Antropologiczny* 53, 1987, pp. 9–10; N. Wolański, "Początki polskiej auksologii po drugiej wojnie światowej na tle wcześniejszych badań nad rozwojem fizycznym dzieci i młodzieży", in: *Uwarunkowania rozwoju dzieci i młodzieży wiejskiej*, ed. A. Wilczewski, Białystok 2012, pp. 63–103; T. Bielicki, A. Szklarska, Z. Welon, Cz. Brajczewski, *Nierówności społeczne w Polsce: antropologiczne badania poborowych w trzydziestoleciu 1965–1995*, Wrocław 1997; T. Bielicki, A. Szklarska, S. Kozieł, Z. Welon, *Transformacja ustrojowa w Polsce w świetle antropometrycznych badań 19-letnich mężczyzn*, Wrocław 2003.

[3] Quoted after: J.M. Tanner, *A History of the Study of Human Growth*, Cambridge 1981, p. 162.

that an individual could achieve in optimal growth conditions, i.e. if his growth were not impeded by any environmental factors, such as quantitative or qualitative nutritional deficiencies, excessive output of energy compared with nutrition, insufficient rest, illness, some types of psychological or nervous stress."[4] We do not know what the genetic optimum is, but by observing the changes in average body height in a population, we can gain an understanding of the economic conditions and hygiene in which consecutive generations grew up.[5]

The amount and quality of food is of key importance to the growth process in the first twenty years of life. Firstly, the energy derived from food is used to survive, i.e. enable basic metabolism, and, secondly, to cover the energy output needed for engaging in an occupational activity and fighting illness.[6] The more severe and long-lasting the nutritional deficiencies, the greater the physical effort, the more frequent and lengthy the period of illness, then the lesser the amount of energy that can be used for growing to the genetic optimum. As a result of environmental deficits, individuals are late entering the age of puberty – when the rate of body growth accelerates. The differences in body height between individuals raised in different environments are greatest at the time of reaching puberty. They also persist after the end of the growth period, although they are somewhat reduced due to the prolongation of the growth period in individuals raised in less advantageous circumstances.

From the perspective of a scholar of economic history, the most attractive data relate to children's rate of growth in the first eighteen years of life because they enable pin-pointing precisely the crisis years when the body height deviated from the norm.[7] In most cases scholars of historical epochs do not possess such documentation and have to base their findings on the measurements of adults, most often those of conscripts. In such cases, the final body height is the result of the

[4] T. Bielicki, A. Szklarska, Z. Welon, Cz. Brajczewski, *Nierówności społeczne w Polsce*, p. 13. More on the issue, see: N. Wolański, *Biologiczny rozwój człowieka*, 8th ed., Warszawa 2012, pp. 30–239, and 572–586.

[5] Changes in the gene pool of the population caused by migrations or natural selection may be a factor which distorts this regularity. The reliability of results requires meeting the condition for the genetic uniformity of the populations compared.

[6] M. Livi-Bacci, *Population and Nutrition: An Essay on European Demographic History*, Oxford 1991, pp. 40–43.

[7] Contemporary knowledge on the rate of growth is presented by A. Siniarska, N. Wolański, "Zmiany tempa rozwoju w ontogenezie człowieka i metody jego badania", *Studia Ecologiae et Bioethicae* 3, 2005, pp. 43–81; N. Wolański, "Problem dojrzałości szkolnej w świetle auksologii", *Wychowanie Fizyczne i Zdrowotne*" 2, 2015, pp. 14–20.

impact of the environment throughout the period of growth, in particular over the first two years of life and during adolescence.[8] The final body height becomes a synthetic measure reflecting living standards over the period of growth and can be used successfully to investigate long-term trends.

* * *

Historians became aware of the cognitive potential of information on the biological aspects of human existence rather late. Their assessment of the standard of living was almost entirely based on real wage indices, and, at times, also on the data on mortality. John Clapham's polemic with John Hammond about the standard of living of English workers at the beginning of the Industrial Revolution is a characteristic example. Hammond challenged Clapham's opinion concerning improved living standards backed by the real wage index, and was of the opinion that although the standard of living improved materially, its quality worsened. Clapham's response was typical: "statistics regarding well-being can never measure people's happiness."[9]

Fifty years later economists began to perceive weaknesses in methods which were limited to measuring the standard of living in monetary terms without taking account of the expenses incurred.[10] The Human Development Index, proposed by Mahbub ul Haq and Amartya Sen, and calculated for the first time in 1990 for UN member states, is an attempt to look at living standards while taking non-monetary factors into consideration. This ratio is currently calculated

[8] J.M. Tanner, *Foetus into Man*: *Physical Growth from Conception to Maturity*, Cambridge 1978, pp. 6–9; J.T. Cole, "The Secular Trend in Physical Growth: a Biological View", *Economics and Human Biology* 1, 2003, pp. 161–168.

[9] J. Clapham, *An Economic History of Modern Britain*, Cambridge 1930, vol. 1, p. VII; J.L. Hammond, "The Industrial Revolution and discontent", *EHR*, 1st series, vol. 2, 1930. On the discussion and its threads related to stature, see: M. Kopczyński, "Standard życia i 'jakość życia' robotników angielskich w epoce rewolucji przemysłowej", in: *Gospodarska, ludzie, władza. Studia historyczne ofiarowane prof. Juliuszowi Łukasiewiczowi w 75. rocznicę urodzin*, ed. M. Kopczyński, A. Mączak, Warszawa 1998, pp. 171–204.

[10] J. Komlos, "Shrinking in a growing economy? The mystery of physical stature during the Industrial Revolution", *JEH* 58, 1998, pp. 779–802; J. Treme, L.A. Craig, "Urbanization, Health and Human Stature", *Bulletin of Economic Research* 65, 2013, pp. 130–141; J.G. Williamson, "Urban disamenities, dark satanic mills, and the British standard of living debate", *JEH* 41, 1981, no. 1; S. Pollard, "Sheffield and Sweet Auburn – Amenities and living standards in the British Industrial Revolution. A Comment", ibid.

as the geometrical average of life expectancy at birth (e_0), which synthetically reflects the health of the population, the average education of 25-year-old adults (in years), the expected duration of education of 5-year-olds and the gross national product per capita according to purchasing power parity. Although the HDI is criticized for being unnecessary, or for taking an insufficient number of variables into account, it is still being calculated, and is increasingly drawing the attention not only of economists but also economic historians.[11]

Historians were not interested in changes in body height until the 1970s. Emmanuel Le Roy Ladurie was the pioneer. In 1963 he announced the results of his studies conducted with anthropologists on the body height of French conscripts from the 1860s.[12] Historical and anthropological research erupted in the 1970s as a result of scholars of the *new economic history*. While Le Roy Ladurie's study was an isolated attempt by a historian to enter a field represented by scholars of another discipline, in American studies, anthropometric data was increasingly being used as an argument in the main polemics between historians. The fact that in the article summarizing the status of research for the years 1970–1994, Richard Steckel quoted 145 works, and in a similar text discussing the period 1995–2008 he referred to 303 new publications, including 14 books,[13] attests to the rate of growth of the relevant literature.

American historical auxology – as the new field of research was named – began to be used in polemics as a result of Robert W. Fogel's and Stanley Engerman's monograph *Time on the Cross* (1974).[14] The authors argued, among other things, that slaves received sufficient nutrition, their working time did not differ from that of white farmers, their life expectancy was slightly shorter than that of white people,

[11] E.A. Stanton, *The Human Development Index: A History, Political Economy Research Institute, University of Massachusetts, Amherst*, Working Paper no. 127, 2007. Attempt to apply HDI to historical economies, see: N. Crafts, "The Human Development Index, 1870–1999: Some Revised Estimates", *EREH* 6, 2002, pp. 395–405.

[12] E. Le Roy Ladurie, N. Bernageau, Y. Pasquet, "Le Conscrit et l'ordinateur: Perspectives de recherche sur les archives militaires du XIX^{e} siècle français, *Studi Storici* 10, 1969, pp. 260–308; E. Le Roy Ladurie, N. Bernageau, "Etude sur un Contingent Militaire (1868). Mobilité géographique, délinquance et stature, mises en rapport avec d'autres aspects de la situation des conscrits", *Annales de Démographie Historique* 1971, pp. 311–337.

[13] R.H. Steckel, "Stature and standard of living", *Journal of Economic Literature* 33, 1995, pp. 1903–1940; id., "Heights and human welfare: recent developments and new directions", *EEH* 46, 2009, pp. 1–23.

[14] *Time on the Cross: The Economics of Negro Slavery*, vols. 1–2, Boston 1974.

while the infant mortality rate was similar. One of the methods of verifying these estimates was to reach out for information that had gone unnoticed to-date, such as data on the slaves' body height. The picture obtained was not unambiguous. On the one hand, the children of slaves showed some degree of malnourishment, which was reflected in the delay in the onset of puberty, yet, on the other hand, when they were of an age considered to be adult and started receiving full adult food rations, the teenage slaves reached puberty which was characterized by a sudden increase in body height that exceeded the average for slaves from the British Caribbean and of people brought in from Africa.[15]

In Great Britain, data relating to body height played an important role in discussions about the standard of living of workers at the outset of the Industrial Revolution. In this respect, Roderick Floud's, Kenneth Wachter's and Anabel Gregory's monograph *Height, Health and History: Nutritional Status in the United Kingdom, 1750–1980*[16] had a pioneering role.

The West

In the late 1990s, Robert W. Fogel put forward the hypothesis that over the past 300 years a significant part of mankind had entered a process he called **technophysio evolution**.[17] Contrary to evolution which consisted of natural selection, technophysio evolution entailed only phenotypic changes. Its essence was the change in the physicality of individuals (height, weight, body measurements) and a demographic regime which evolved from a system of high mortality and short life expectancy to one based on low mortality, low fertility and an extended life expectancy. These changes were derived from the growing domination of humankind over the environment thanks

[15] On the birth of the new science object S.L. Engerman, "Personal reflexions on the 1982 special anthropometric issue of social science history", *Social Science History* 28, 2004, pp. 345–349; R.H. Steckel, "Slave Height Profiles from Coastwise Manifests", *EEH* 16, 1979, pp. 363–380.

[16] R. Floud, K. Wachter, A. Gregory, *Height, Health and History: Nutritional Status in the United Kingdom, 1750–1980*, Cambridge 1990.

[17] R.W. Fogel, D.L. Costa, "A theory of technophysio evolution, with some implications for forecasting population, health care costs, and pension costs", *Demography* 34, 1977, pp. 49–66; R.W. Fogel, *The Escape from Hunger and Premature Death, 1700–2100: Europe, America and the Third World*, Cambridge (Mass.) 2004; R. Floud, R.W. Fogel, B. Harris, Sok Chul Hong, *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700*, New York 2011.

to technological progress, and were proliferated due to the diffusion of knowledge and not a modification of the gene pool. The scope of the changes as shown by the example of some countries is illustrated in Table 1.

Table 1. The secular trend in body height in the USA, England, France, Sweden and Poland, 1800–1980

Country	1800	1850	1900	1950	1980
USA					
e0	–	39.5	49.6	69.1	74.4
body height	172.9	171.1	170.0	177.3	179.1
England					
e0	40.3	41.1	46.1	66.1	70.6
body height	168.6	171.2	168.0	172.6	175.0
France					
e0	32.0	40.5	45.1	60.9	75.7
body height	163.0	164.3	165.4	168.0	171.2
Sweden					
e0	38.7	43.7	52.5	69.3	75.2
body height	166.7	167.3	169.5	173.9	177.2
Poland					
e0	29.5	27.6	39.6	56.1	66.0
body height	–	163.0	165.2	170.5	175.3

Source: R. Floud, R.W. Fogel, B. Harris, Sok Chul Hong, *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700*, New York 2011, p. 69; E. Piasecki, *Ludność parafii bejskiej (woj. kieleckie) w świetle ksiąg metrykalnych z XVIII–XX w.*, Wrocław 1990, pp. 282–285; *Przeciętne dalsze trwanie życia w latach 1950–2012*; http://demografia.stat.gov.pl/bazademografia/TrwanieZycia.aspx (accessed 29 March 2014).

The model constructed by Fogel is based on a relationship observed both in contemporary and historical data between mortality and body height and the height/weight ratio (BMI).[18] Chronic malnutrition in pre-industrial populations led to adaptation by reducing body height, which in turn reduced the demand for energy needed for basic metabolism. When the food supplies increased as a result of the agricultural and transport revolution, body height also increased, and this phenomenon was accompanied by a reduction in mortality and the extension of life expectancy. From the energy balance based on estimates of food consumption in France and England at the end of the eighteenth century, it follows that at least 10% of the poorest people in both countries lived on the fringes of biological existence and a further 10% could only

[18] BMI is the product of weight in kilograms and the square of body height in meters.

afford limited physical effort.[19] Agronomic progress led to an increase in the standard of living, and people who were better nourished could work harder than before. As a result, as Jan de Vries described, consumer aspirations which were related not only to food but also to tangible goods rose.[20]

Table 1 shows that in the nineteenth century life expectancy and average height were not always directed the same way. But if in France and Sweden, as well as in Poland, the two phenomena accompanied one another until the mid-nineteenth century, America and England noted a regression in body height. This can be explained by the appalling living conditions in towns, the changing relationships between the prices of food and other goods, and the increasing inequalities regarding income. A return to the path of increasing height was only possible as a result of the improving standards of hygiene, which took place in the late nineteenth and early twentieth centuries.

Poland

As mentioned earlier, Czekanowski's research showed that, starting with the generation born in the 1860s, a systematic trend in the increase in body height was noted in the Kingdom of Poland. Peasant conscripts from the Miechów district born before 1860 measured an average of 161.2 cm, while those born in the 1880s were 2.5 cm taller.[21] Czekanowski put this down to an improvement in living conditions as a result of peasants being granted property rights – "the accuracy with which the social revolution was registered by our anthropological thermometer leaves nothing to be desired. I would even say that it exceeds all expectations."[22] Later studies showed that connecting the change in the conscripts' height to the granting of property rights was an oversimplification. Jan Mydlarski's study on conscripts from the Military Replenishment Board in Tarnów proves that in this

[19] R. Floud, R.W. Fogel, B. Harris, Sok Chul Hong, *The Changing Body*, pp. 41–61.

[20] J. De Vries, *The Industrious Revolution: Consumer Behavior and the Household Economy, 1650 to Present*, New York 2008.

[21] K. Kosieradzki, "Przyczynek do charakterystyki fizycznej ludności męskiej powiatu miechowskiego na zasadzie pomiarów rekrutów w ciągu 30 lat 1874–1903", *Czasopismo Lekarskie* 7, 1905, p. 263.

[22] J. Czekanowski, "Przyczynki do bilansu społeczno-antropologicznego Królestwa Polskiego", in: *Księga pamiątkowa ku czci Bolesława Orzechowicza*, Lwów 1916, pp. 227–228.

period – when conscripts in the Miechów district were increasingly taller – the ratio of individuals measuring more than 155 cm in the Galician Tarnów district steadily declined. And in Galicia the peasants were enfranchised earlier. Today we know that the body height of Poles in Wielkopolska started to increase after 1860. This phenomenon was not so much the result of changes in the agrarian system in particular partitions, as a general improvement in the standard of living on a nationwide scale.[23]

Table 2. Body height of conscripts in Polish lands (born between 1845 and 1982)

Year of birth	Kingdom of Poland	Galicia	Wielkopolska	Poland
1845	163.0[b]	161.9[a]		–
1855	163.0[b]	161.3[a]		–
1861	163.0[b]	161.4[a]	165.5[de]	–
1871	164.3[b]	163.8[b]	166.1[df]	–
1881	164.9[b]	164.8[b]		–
1887	165.2[b]	165.8[b]	166.5[dg]	–
1892	165.3[b]	–	167.3[dh]	–
1900	–	–	–	165.0[b]
1906	–	–	–	165.9[b]
1946	–	–	–	170.5[c]
1957	–	–	–	173.2[c]
1967	–	–	–	175.3[c]
1976	–	–	–	176.9[c]
1982	–	–	–	177.4[c]

Legend:
[a] aged 20–22
[b] aged 21
[c] aged 19
[d] aged 20
[e] birth decade 1860–1870
[f] birth decade 1870–1880
[g] birth decade 1880–1890
[h] birth period 1891–1895

Source: M. Kopczyński, "Agrarian reforms, agrarian crisis and biological well-being in Poland, 1845–1892", *Economics and Human Biology* 5, 2007, p. 463, T. Bielicki, A. Szklarska, S. Kozieł, Z. Welon, *Transformacja ustrojowa w Polsce w świetle antropologicznych badań 19-letnich mężczyzn*, Wrocław 2003, p. 19; O. Nowak, *Wysokość i masa ciała młodych mężczyzn w okresie przemian historycznych i społeczno-gospodarczych drugiej połowy XIX i początku XX wieku na ziemiach polskich*, Poznań 2011.

[23] J. Mydlarski, "Analiza antropologiczna ludności powiatu pilzneńskiego", *Archiwum Towarzystwa Naukowego we Lwowie*", sec. III, vol. III, fasc. 8, Lwów 1924, p. 6; Czekanowski, *Zarys antropologii Polski*, p. 119.

The attempt to illustrate the data for earlier periods requires making a comparison of the intravital measurements provided in written sources with skeletal data. As skeletons cannot usually be measured *in situ*, we have to refer to measurements of long bones.[24] Several equivalent methods are used in the measurements based on the observation that the size of long bones is correlated to body height. However, it should be noted that the results obtained using Manouvier's, Pearson's, Trotter-Gleser's or Breitinger's and Bach's methods vary by 1 to 4 cm. Additionally, "each of the methods only characterizes groups that are similar in build to the ones on which the creators of the methods based their models."[25] Pearson's method is considered to be the best method for Poland.

Another doubt concerns the size of the samples. The largest Polish early Middle-Age cemetery – Ostrów Lednicki – contained the remains of 368 men and 267 women. In terms of archeological sites, this is a large number of remains, but for a historian using written sources, it is insufficient. It is recommended that samples should have more than 500 observations.[26] Because the cemeteries are usually smaller, the calculated confidence intervals of the arithmetical average body height are wide. Other doubts may be raised in respect of the chronology of cemeteries in areas with long-term settlement continuity. Many cemeteries – in particular those used in the late Middle Ages and then in early modern times – had been used for long periods of time. The mechanical attribution of average heights in mid chronological brackets only obscures the picture.

In literature, attempts were made several times to synthetically present the already large number of empiric data.[27] All the data

[24] J. Piontek, *Biologia populacji pradziejowych – zarys metodyczny*, Poznań 1996.

[25] J. Strzałko, "Proporcje budowy dawnej ludności Kołobrzegu na podstawie szczątków kostnych z cmentarzysk przy kolegiacie kołobrzeskiej (XIV–XVIII w.)", *Przegląd Antropologiczny* 32, 1966, p. 181.

[26] J. Komlos, "How to (and how not to) analyze deficient height samples", *Historical Methods* 37, 2004, p. 163.

[27] J. Gładykowska-Rzeczycka, "Wzrost ludności Pomorza Wschodniego na przestrzeni wieków", *Pomerania Antiqua* 5, 1974, pp. 211–217; A. Wiercińska, "Badania nad zmiennością wysokości ciała w Polsce", *Wiadomości Archeologiczne* 38, 1973, pp. 373–377; A. Wiercińska, "Zmienność cech typów budowy ciała w ciągu ostatniego tysiąclecia na podstawie materiału szkieletowego z Wiślicy", *Materiały i Prace Antropologiczne* 98, 1980, pp. 133–203; H. Stolarczyk, W. Lorkiewicz, "Wysokość ciała ludności terytorium Polski od neolitu do współczesności", in: *Miscellanea Archeologica Thaddeo Malinowski dedicata*, ed. T. Rożnowski, Słupsk–Poznań 1993, pp. 325–340; J. Kozak, *Biologiczne skutki zróżnicowania społecznego populacji ludzkich z terenu Polski w okresie feudalnym i przełomu industrialnego*, Poznań 1998.

showed that the tallest body heights were in the Neolithic period (5200–1900 BCE, 167.2 cm) and in the late Middle Ages, and then decreased in early modern times. This is confirmed by Jan Strzałko's research on bodies buried close to the Kołobrzeg collegiate church and by Alina Wiercińska's study on the population of Wiślica and surrounding areas.[28]

Table 3. Average height of a man in Poland from the Middle Ages to the beginning of early modern times

Centuries	H. Stolarczyk & W. Lorkiewicz Poland	J. Kozak* Poland	J. Strzałko Kołobrzeg	A. Wiercińska Wiślica
–13th	165.7	166.8	–	167.8
14th–15th	167.7	167.7	168.7	168.4
16th–18th	166.9	165.3	167.8	166.6

* Regrouped data, the Kołobrzeg cemetery analyzed by J. Strzałko, and the Gniezno cathedral graves have not been included.

Wiercińska associated the decrease in body height in early modern times with the serf-based farming system and the ravages of war.[29] However, compliance of the East- and West-European trend is an inducement to seek global and not local explanations.[30] In this light the most probable reason for the increase in body height in Poland in the late Middle Ages was the drop in population following the outbreak of the Black Death, which is confirmed by the demands of fifteenth-century knights to bind peasants to the land. This depopulation was favorable for raising farm animals, which in turn could lead to increased consumption of meat and milk compared to the prior period. The fall in average body height in early modern times may be partially attributed to a change in the nutrition model consisting of the increasing importance of plant-derived food at the expense of food originating

[28] The isolation of these two studies covering both the Middle Ages and early modern times is a type of check in respect of the studies consisting of summarizing data from various cemeteries. If in the latter case the result can be distorted due to local genetic drift, in the case of research on one cemetery it is rather improbable.

[29] A. Wiercińska, "Zmienność cech typów budowy ciała", p. 374.

[30] On the Western European trend see: N. Koepke, J. Baten, "The biological standard of living in Europe during the last two millennia", *EREH* 9, 2005, pp. 61–95; R.H. Steckel, "Health and nutrition in the pre-industrial era: insights from a millennium of average heights in northern Europe", in*: Living Standards in the Past. New Perspectives on Well-Being in Asia and Europe*, ed. R.C. Allen, T. Bengtsson, M. Dribe, Oxford 2005, pp. 227–54.

from animals.[31] It follows from Andrzej Wyczański's calculation that carbohydrates[32] constituted 82% of the daily nutritional norm of the rural population in the Kingdom of Poland in the sixteenth and first half of the seventeenth century. A similar percentage is typical for Italy and pre-industrial France. The structure of food prices contributed to this. In Italy in the early seventeenth century the cost of 1,000 kcal obtained from beef was five times higher than the cost of the respective calorie content obtained from bread.[33] In the Polish Lithuanian-Commonwealth (data from Gdańsk from the eighteenth century) the proportion was even higher – 6.25:1.[34] In this context Wilhelm Abel's estimates dating from 1937 referring to the 86% drop in meat consumption in early modern times compared with the late Middle Ages do not seem improbable.[35] Only the propagation of new methods of animal husbandry enabled the production of animal produce to be increased to a degree enabling an increase in consumption despite the growing population.[36]

Reconciling the results obtained on the basis of archaeological data with written sources remains a problem. The average body height in early modern times exceeds the average for conscripts in the 1860s by as much as 3–4 cm. Such a dramatic change seems rather unlikely. When and why would it have occurred? Although the first half of the nineteenth century – from the Napoleonic wars to the failed crops in the 1850s – was not a period of prosperity, it is difficult to imagine that the decrease in height could have been that great.

Anyway, the course of the body height trend in Poland was similar to that in Europe. Between the late Middle Ages and early twentieth century it was U-shaped, and this was related to changes in nutrition as well as the frequency of contagious diseases.

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[31] A. Wyczański, *Studia nad konsumpcją żywności w Polsce w XVI i pierwszej połowie XVII w.*, Warszawa 1969; E. Kaczyńska, "Zdrowe jedzenie – zalecenia i polska rzeczywistość w XIX i XX w.", *Roczniki Dziejów Społecznych i Gospodarczych* 59, 1999, pp. 127–154.

[32] A. Wyczański, *Studia*, p. 112.

[33] M. Livi-Bacci, *Population and Nutrition*, p. 86.

[34] *Historia Polski w liczbach*, vol. 1: *Państwo i społeczeństwo*, ed. A. Jezierski, A. Wyczański, Warszawa 2003, p. 105.

[35] E. Kaczyńska, "Zdrowe jedzenie", pp. 140–141; M. Livi-Bacci, *Population and Nutrition*, pp. 85–95.

[36] R.W. Fogel, *The Escape from Hunger and Premature Death*, M. Kopczyński, *Ludzie i technika. Studia z dziejów cywilizacji przemysłowej*, Warszawa 2009, pp. 55–65; V. Smil, "Eating Meat: Evolution, Patterns and Consequences", *Population and Development Review* 28, 2002, pp. 599–639.

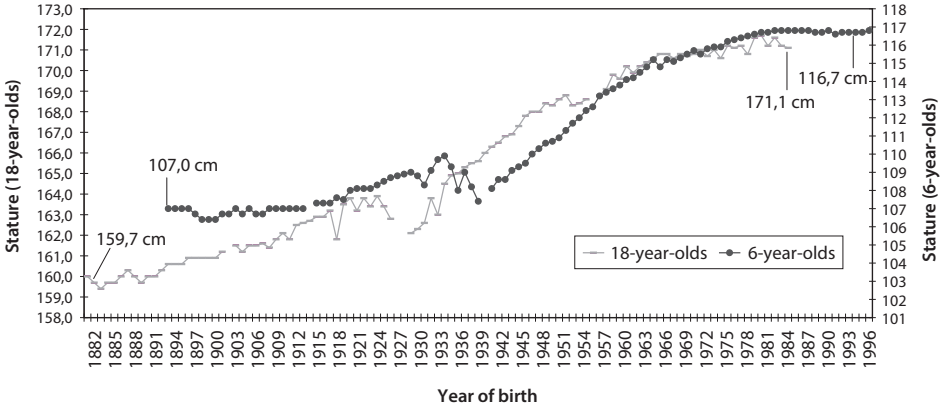
Asia

Contemporary anthropological research shows that the technophysio evolution not only occurred in Europe and North America, but also on other continents.[37] To-date, the cases of Japan and Korea are best documented and will be referred to in further parts of this study. In respect of Korea, historic anthropometry provides us with an important argument in the multi-decade discussion on the outcome of Japanese colonial reign (1910–1945), on the other hand, comparing the height of inhabitants of both North and South Korea, which was divided in 1953, shows that socio-political conditions have an impact on human physicality even in the of genetically homogenous populations.

Japan

The evolution in the height of Japanese people since the Meiji period has been documented by measurements of children aged between six and eighteen at the request of the educational authorities since 1900.

Diagram 1. Height of Japanese students (aged 6 and 18), born between 1882 and 1998



Source: Stature by Age and Gender (F.Y. 1900–2004), Historical Statistics of Japan, ch. 24.3: http://www.stat.go.jp /english/data/chouki/24.htm (accessed 26 March 2014).

In the case of 18-year-old youths, the difference between the cohorts born in 1887 and in 1986 is 11.1 cm. In the case of 6-year-olds born between 1899 and 1998, it is 10.4 cm. The biggest leap – of 19 cm –

[37] See e.g. Ph.B. Eveleth, J.M. Tanner, *Worldwide Variation in Human Growth*, 2nd ed., Cambridge 1990.

was noted among 12-year-old boys born between 1893 and 1992. The latter reflects both the increasing body height as well as the lowering of the age of pubescence. Both ratios – body height aged 18 and the beginning of puberty – may be regarded as reflecting the quality of life.

As shown in Diagram 1, the increase in body height was not a homogenous process. A clear slump in the trend for 18-year-olds took place between the cohorts born in the years 1925–1932, which can be attributed to the Great Depression. However, what is striking is the constant and uninterrupted upward trend in body height of the cohorts born during the Second World War. The unfavorable conditions in early childhood were perhaps compensated during puberty. Measurements of 6-year-olds born between 1935 and 1947 nevertheless show that the Second World War had an unfavorable effect on the physicality of the Japanese, when there was a noticeable drop in body height. The post-war, very fast and four-decade-long tall stature trend co-existed with the "Japanese economic miracle". The trend was inhibited in the 1980s. It is difficult to say whether this resulted from the depletion of the gene potential or whether the observed stagnation was related to the economic slump of the 1990s.

Korea

The course of changes in body height in Korea is more difficult to track due to the absence of data which is comparable in quality to that of the Japanese. For the past decades, anthropometric measurements drawn up by the Korean Agency for Technology and Standards are most often used for industrial purposes. The first national anthropometric snapshot was carried out in 1979 on a sample of 17,000 people ranging in age from 6 to 50.[38] Based on this data, we can form an opinion on the increase in body height starting from the 1930s. Similar data can be found in the archives of the Korean Medical Insurance Corporation (KMIC), which, since launching universal health insurance for state employees in 1989, conducts medical checks on those insured. In both cases a source of error could be the fact that the body height of individuals aged over 40 gradually decreased due to the deterioration of intervertebral discs. As a result, the data for individuals born earlier are understated. Another factor which distorts the trend

[38] Young-suk Lee, "Anthropometric data analysis for body shape modeling in Korea", *Korean Journal of Physical Anthropology* 26, 2013, no. 2, pp. 61–69. The anthropological snapshots were taken in 1979, 1986, 1992, 2003, and 2010.

is the greater survivorship of individuals with average and larger body height, which leads to an increased average in older generations. It is unclear whether both effects cancel each other out or lead to the error being multiplied. Also, the KMIC data is overstated due to the fact that, contrary to the anthropometric snapshots, they are not based on random samples. The majority of employees insured are white-collar workers, teachers and officials, which with regard to people born before the 1960s could systematically overstate the average body height.[39]

Anthropometric data relating to the inhabitants of the Democratic People's Republic of Korea, a closed country which does not even publish basic statistical data, is an even greater problem. The famines which hit the country in the 1990s and cost the lives of 600,000 to 1 million people caused the regime, which had applied for foreign food aid, to allow foreign specialists into the country to carry out a series of controlled surveys on women and children which would enable estimating the scale of malnutrition.[40] The second source that allows us to look behind the iron curtain dividing the Korean Peninsula are the measurements of refugees who fled to China or South Korea. In addition to the data collected in the last decades, there are earlier measurements carried out by the Japanese during the colonial period (1910–1945).

Until 1876, the Korean Peninsula was closed to foreigners. It had always remained politically subordinate to China, but the control was only symbolic. This rather comfortable isolation ended at the turn of the nineteenth/twentieth century. The fate of Korea was decided by the Japanese-Chinese war of 1894–1895, as a result of which Chinese dominance definitely ended and a brief period of its first independence (1895–1905) began, when the Korean Empire vacillated between Japanese, Chinese and Russian influences. Russia's defeat in the war with Japan (1904–1905) ushered in a period of Japanese dominance. In 1910 the Japanese forced the last Korean ruler of the Joseon dynasty, Emperor Sunjong, to abdicate, and established an administration subordinated to a Governor General.

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[39] I. Gill, "Stature, consumption and the standard of living in colonial Korea", in: *The Biological Standard of Living in Comparative Perspective*, ed. J. Komlos, J. Baten, Stuttgart 1998, p. 135.

[40] Assessing mortality after S. Haggard, M. Noland, *Famine in North Korea. Markets, Aid and Reform*, New York 2007, pp. 6–11. The surveys are characterized by D. Schwekendiek, "Incorruptible information on North Korea? An overview and review of anthropometric assessments", *Journal of Peace and Unification Studies* 1, 2009, pp. 317–364.

Most scholars assess the colonial era through the prism of political events, viewing it mainly as an age of persecution of the supporters of Korean independence and attempts at the cultural assimilation of the Koreans by the Japanese. Although the new authorities tried to develop and modernize the education system, the language in which Koreans were taught was Japanese, and students were forced to worship the Japanese Emperor. All traces of independence were obliterated in the public domain, and Koreans were even forced to adopt Japanese names.

However, there was another side to colonization of Korea. It marked the onset of industrialization, rice production increased and there was a population explosion.[41] It was also marked the establishment of the first Korean firms, some of which still exist. But, because Koreans were second-class citizens in their own country – of which the disparity in the wage and employment structure is evidence – it is difficult to assess colonial rule unequivocally. The 60% increase in rice crops between 1915 and 1937 were not necessarily synonymous with an increase in consumption due to the high increase in population, exports to Japan and falling prices, which led to the income of direct producers remaining unchanged.[42]

From the beginning of the twentieth century, we have a greater number of measurements; however none of them can be considered representative. The first measurements were made by the English anthropologist Alfred Stripling, who obtained an average for adult men of 163.8 cm, whereas Japanese anthropologists who measured soldiers obtained averages of 161.9–163.8 cm. Other studies referred to prisoners and the inhabitants of Seoul slums; they gave results of 160–161 cm. Mitsuhiko Kimura, the first person to consider body height data as a source for assessing Japanese colonial policy in Korea, emphasizes prudently that in some areas – education, rice production, mortality – Japanese rule brought progress, but in others – housing conditions and above all Korean self-assessment – it had negative consequences.[43]

Since then, three works have attempted to systematize the changes in body height. Insong Gill based his studies on the data of the Korean

[41] Myung Soo Cha, Nak Nyeon Kim, "Korea's First Industrial Revolution, 1911–1940", *EEH* 30, 2011, pp. 1–15. Similar assessment of the Japanese occupation from an economic point of view, see A. Kohli, *State-Directed Development: Political Power and Industrialization in the Global Periphery*, Cambridge 2004, pp. 27–61.

[42] M. Kimura, "Standards of living in colonial Korea: Did the masses become worse off or better off under Japanese rule?", *JEH* 53, 1993, pp. 629–652.

[43] Ibid., p. 649.

Medical Insurance Corporation (KMIC), Seong-Jin Choi and Daniel Schwekendiek expanded these observations by measurements of the body height of political prisoners born in the years 1890–1916, held in the Soedaemun Prison in Seoul under colonial reign, and Duol Kim and Heejin Park studied the measurements of those who died sudden deaths, published by the Japanese authorities, whose families were being sought through advertisements placed in official newspapers.[44]

The results are shown in Table 4.

Table 4. Body height of Koreans born between 1890 and 1992

Year of birth	Body height in cm	Change (cm/decade)	Comments	Japanese
1890	162.9	–	Soldiers	159.7
1910	164.5	0.8	Prisoners	161.8
1920	165.3	0.8	Insured with KMIC	163.5
1930	167.4	2.1	Insured with KMIC	162.1
1940	168.2	0.8	Insured with KMIC	165.6
1950	168.8	0.6	Insured with KMIC	168.4
1960	170.3*	1.5	Insured with KMIC	169.8
1961	166.8*	–	Anthropological snapshot 1979	169.6
1968	167.9	1.6	Anthropological snapshot 1986	170.8
1979	171.8	3.5	Anthropological snapshot 1997	171.2
1985	172.9	1.8	Anthropological snapshot 2003	171.2
1992	172.9	0.0	Anthropological snapshot 2010	–

Source: soldiers: M. Kimura, "Standards of living in colonial Korea: Did the masses become worse off or better off under Japanese rule?", *JEH* 53, 1993, p. 645; prisoners and insured: Seong-Jin Choi, D. Schwekendiek, "The biological standard of living in colonial Korea, 1910–1945", *Economics and Human Biology* 7, 2009, p. 260; anthropological snapshot: Young-suk Lee, "Anthropometric data analysis for body shape modeling in Korea", *Korean Journal of Physical Anthropology* 26, 2013, p. 62; Japan: stature by age and sex (F.Y. 1900–2004), Historical Statistics of Japan, ch. 24.3: http://www.stat.go.jp /english/data/chouki/24.htm 18 years old males (accessed 26 March 2014).

* The decrease in the average between the cohorts from 1960 and 1961 is the result of the change in the basis of estimation. Insured persons were middle-class individuals, the participants of the anthropological snapshot are a representative sample of the population.

The schedule of measurements shows that the first decade of colonial rule did not result in any major changes. Increases in body height of

[44] I. Gill, Stature; Seong-Jin Choi, D. Schwekendiek, "The biological standard of living in colonial Korea, 1910–1945", *Economics and Human Biology* 7, 2009, no. 2, pp. 259–264; Duol Kim, Heejin Park, "Measuring living standards from the lowest: Height of the male Hangryu deceased in colonial Korea", *Economics and Human Biology* 48, 2011, no. 4, pp. 590–599.

about 0.8 cm per decade until 1920 may be a statistical illusion resulting from the nature of the data, which is difficult to compare. Soldiers born around 1890 were usually from lower social classes and individuals insured by KMIC represented the middle classes and were therefore probably taller than prisoners, of whom 42% were peasants. A significant leap – of as much as 2.1 cm – was noted in the 1920s, when the first effects of the reforms introduced by the Japanese became visible. In the following two decades, the pace of growth towards a taller stature weakened, which was probably the result of the Great Depression and the Second World War. However, generally the colonial period does not look bad in terms of living standards.

A similar outcome of Japanese rule is observable in Taiwan (1895–1945). Kelly Olds, as well as Stephen L. Morgan and Shiyung Liu, who studied this problem, noted the increase in body height in the 1920s and its stagnation in the following decades.[45]

The measurement of the bodily dimensions of those who died suddenly, i.e. mainly poor individuals, quoted above, shows that in this group, the average body height increased by 2.2 cm between cohorts born in 1880 and 1920. This suggests putting forward the hypothesis that in the colonial period the progress of civilization benefited the poorer classes by reducing the stratification of income.

After the Korean war ended, the secular trend accelerated twice whereas the marked reduction in the average height of those born between 1960 and 1961 is the result of a change in the source. As already stated, the KMIC data relates to the middle class, whereas the anthropological snapshot from 1979 is that of a representative group. In the next twenty-five years, under the dictatorship of General Park Chung He, and the country's accelerated modernization, body height increased very rapidly,[46] at a rate of about 3.5 cm per decade between 1968 and 1979 – one of the fastest on a global scale. It was only inhibited after 1985 and, as in the case of Japan, it is difficult to determine whether it results from the depletion in reserves of the gene potential.

[45] K.B. Olds, "The biological standard of living in Taiwan under Japanese occupation", *Economics and Human Biology* 1, 2003, no. 2, pp. 187–206; and S.L. Morgan, Shiyung Liu, "Was Japanese colonialism good for the welfare of Taiwanese? Stature and the standard of living", *China Quarterly* 192, 2007, pp. 990–1017.

[46] The outcome of Park's rule continues to raise controversies. The dictator-modernizer is condemned for his constant violations of democratic rules and human rights, although his merits in the field of modernization are obvious, see: M. Kopczyński, "'Cud nad rzeką Han'. Park Chung Hee czy 'państwo rozwoju gospodarczego'?", *Dzieje Najnowsze* 46, 2014, no. 4, pp. 73–91.

The data in Table 4 shows the harmonization of genetic and environmental factors. In the cohorts born in the years 1890–1910, where data for soldiers and prisoners is available, the Koreans were 2–3 cm taller than the Japanese. The ratio was reversed for individuals born between 1961 and 1968, when Japan's economic modernization was already advanced, whereas in Korea it had only just begun. In the 1980s, relations returned to their previous state when the Koreans again outgrew the Japanese. Although the gene potential favors the Koreans, in the 1960s socio-economic modernization leveled it out, giving the Japanese the advantage. Only the equalization of living standards has allowed the Koreans' higher gene potential to once again come to light.

Data on the body height of North and South Koreans attests to the fact that the trend towards a taller stature is reversible, or at least stoppable in the event of deteriorating living conditions. In this instance we have populations with identical gene potential but living in completely different economic conditions (Table 5).

Table 5. Body height of South and North Koreans

Year of birth	South	North	Difference	Source
1888/1890	161.4	163.4	–2.0	Soldiers
1918	162.3	163.4	–1.1 cm	Workers
1918	163.8	165.2	–1.4 cm	Students
1932–1941	164.1	164.4	+0.3	North Korean refugees
1942–1951	166.5	164.6	+1.9	North Korean refugees
1952–1961	167.9	165.0	+2.9	North Korean refugees
1962–1966	169.6	165.4	+4.2	North Korean refugees
1967–1971	171.3	165.8	+5.5	North Korean refugees
1972–1976	171.7	165.8	+5.9	North Korean refugees
1977–1979	171.3	164.9	+6.4	North Korean refugees
1981–1982	170.8	164.9	+5.9	North Korean refugees

Source: 1888/1890 to 1918 cohorts: M. Kimura, "Standards of living in colonial Korea", p. 645; other data: Sunyoung Pak, "The biological standard of living in the two Koreas", *Economics and Human Biology* 2, 2004, p. 513.

At the turn of the twentieth century the body height of North Koreans exceeded the data concerning South Koreans in a statistically significant manner. Changes in the opposite direction occurred after the division of the Korean Peninsula as a result of the truce of 1953. However, despite the fact that initially – in the generation born in the

years 1932–1941 – the differences evened out, in subsequent decades, the secular trend in the north stopped and even began to reverse in those born in the late 1970s. As a result, the difference in body height increased to 6 cm in favor of the south. It cannot be ruled out that the actual differences are even greater as the population of North Korean refugees is not representative of the general population. The difference between the north and south is increasing despite the campaign to increase the height of the subjects initiated by Kim Ir Sen in the 1980s, which was supposed to have been achieved by intensifying physical exercise among school children.[47] Anthropometric data cannot be falsified, even in a country where propaganda triumphs on a scale that is unimaginable in the normal world.

Conslusions

To conclude these deliberations, it should be mentioned that over the almost forty years of its existence, historical anthropometry has passed from methodological curiosity to knowledge which can contribute to highlighting fundamental problems in human history. Its cognitive merits were already known to physical anthropologists in the nineteenth century. But specialists on the subject concentrate mainly on the present and only rarely go back into the past, and even when they do, they most often base on the achievements of their predecessors. The fortunate interdisciplinary encounter between anthropologists and professional historians in the early 1980s opened up new perspectives for research. Historians who knew the source documents could provide many more observations than the anthropologists. Moreover, they were able to revive sources which had hitherto been omitted by historians, that is the data regarding draft boards. Thus, a new field for research was born which, thanks to the work of Robert W. Fogel and his students, is continually expanding its scope, going beyond pure anthropometry to issues of health, illness and productivity in the past. This brings to mind the analogy with historic demographics which at the end of the 1950s, thanks to the meeting of the professional demographer Louis Henry with the historian Gustav Fleury also flourished, becoming one of the most dynamically developing areas of social

[47] D. Schwekendiek, *A Socioeconomic History of North Korea*, Jefferson 2011, pp. 91–92. At the same time, a minimum high requirement for conscripts was reduced from 150 to 127 cm.

history.[48] Time will tell whether historic anthropometry will play as great a role as historic demography played in its time. Whatever the result, the example shows that crossing the boundaries of narrow specializations and joining of forces of representatives of seemingly distant sciences has a great future.

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[48] L. Stone, "Past achievements and future trends", *Journal of Interdisciplinary History* 12, 1981, pp. 56–66.

Michał Kopczyński

Body height as a measure of the standard of living: Europe, America and Asia (Summary)

Historical auxology – the study of changes in all aspects of human physical growth, especially the body height – became a thriving branch of economic history in the 1970s. The body measurements – its height and the mass/height index (BMI) – reflect the standard of living of the people researched in the first 18–20 years of their life. According to Robert W. Fogel, the last 300 years have been marked by a technophysio evolution leading to permanent increase in human body height and mass. The evolution consists in phenotypical, not genetic, changes impacted by the environment and fuelled by technological advancement in agriculture, transportation, and municipal engineering, with the channel of its dissemination being the diffusion of knowledge and technical abilities.

The paper presents an overview of studies concerning Western Europe, the USA, Poland, and Japan and Korea. In the Polish territory – in all three partitions – the average body height has been steadily increasing since in the 1860s. Previous changes in body height were not permanent. The highest average body height was noted in Late Middle Ages and then decreased until the mid-19th century.

The comparison of the evolution of body height in Japan and Korea in the 19th and the 20th century indicates the co-dependence of genetic and environmental conditions – the Japanese were higher than Koreans up until the mid-20th century, but as the level of economic development in both countries became equal, the height of Koreans surpassed Japanese averages. Even more dramatic influence of the environment can be noticed in the comparison between South and North Korea over the 20th century.

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