Human Height

Joerg Baten and Matthias Blum

Please note: This is not the final version of this paper. A later version was published as "Human Height" in Jan Luiten van Zanden, Joerg Baten, Marco Mira d'Hercole, Auke Rijpma, Conal Smith, Marcel Timmer (eds.), *How Was Life? Global Well-being since 1820*. OECD, Paris, 117-138.

Introduction

Human development and the shape of human bodies seem unrelated areas. However, there is much evidence that at least the average height of large numbers of individuals can be considered as an important welfare indicator. Development economists and other specialists in the fields of nutrition and health have studied the share of stunted (i.e. shorter than expected) children. The rationale underlying these studies is that the human body reduces its growth if the nutritional situation worsens, or if diseases reduce the available amount of nutrients. The reflection of nutritional or health-related problems in the human body provides a relatively undistorted indicator, whereas many other welfare proxies (such as calories or protein per capita, real income, etc.) require quite complicated measurement procedures, which are particularly difficult to obtain in developing countries and in historical studies. However, anthropometric data require a set of techniques in order to be transformed into informative and undistorted indicators. This chapter reviews these methods, and provides evidence on differences of human stature between countries and regions since around 1820s.

By providing a comprehensive dataset on average human height across all world regions, this chapter provides an alternative view of the history of human well-being and health status. Human stature has been used as a proxy indicator for health, especially for time periods and societies in which other indicators are not available or of unclear quality. For example, evidence on heights is available for Africa, Southeast Asia and other world regions during the 19th century, a period when other well-being indicators are very scant.

But what does it mean that height is a proxy indicator? The value of an additional year of life is relatively obvious for any human being, whereas an additional centimeter of height does not have a direct meaning. Height developments and differences (across countries and periods) only reveal their importance if their correlation with other components of health and the ‘Biological Standard of Living’ (Komlos 1985 suggested this term) is known to the observer. This correlation is quite well-established (even if there are some exceptions) and the further we go back in time, the closer the correlation. But even in 20th century Norway, a correlation was shown: Robert F. Fogel - drawing on the research of Waaler (1984), who measured several thousand Norwegian men and then followed them in a longitudinal study - reported in his Nobel Prize lecture (1994) that as late as the 1960s and 1970s a 17.5-cm height deficit meant for a Norwegian man a 71% higher risk of dying in the next period of their life, a staggering difference when one considers that at the time Norway's nutritional ratings were unmatched. Having analysed height data for the birth cohorts of 1860, 1900, and 1950, Baten and Komlos (1998) concluded that every centimetre above and beyond a given population's average height translated into a life-expectancy increase of 1.2 years.[1] Thus a mere half-centimetre deviation from the population average is significant, representing six months of life. The correlation between height and longevity is even closer among children (Billewicz and MacGregor, 1982; Martorell and Habicht, 1986).

Another implication of the fact that height is only a proxy indicator of health status is that governments did not perceive it to be an important reflection of their own policies. For example, some governments engaged in some ‘window-dressing’ when development indicators such as national income, life expectancy, school enrollment etc. were published: for

[1] The third cohort analysed by Baten and Komlos (1998) refers to those who have attained adulthood at some point between the 1970s and the present. Baten and Komlos (1998) also found that differences in the coefficient linking height and life expectancy among the three cohorts were negligible.

example, the Soviet Union tried to make their statistics look better than they were in reality, while Nazi Germany did the same. A proxy indicator of well-being which we study today, in the 21st century, but whose informative value was not clear to contemporaries, will be less vulnerable to manipulation. Indeed, several studies on the communist countries and Nazi Germany have revealed that human stature provides important insights there were hidden when looking at other indicators.

Description of the concepts used

Human stature is a well-established indicator for the biological standard of living, positively correlated, along with good health and longevity, with a nutritious diet.[2] In the 1980s Robert F. Fogel, Richard Steckel, and John Komlos pioneered its use in the field of economic history, and a large body of literature has emerged since (Steckel, 2009; Komlos and Baten, 2004; Floud, Fogel, Harris, Wong and Hatton, 2013). Anthropometric studies of individual countries have made a significant contribution to welfare analysis over the past several decades, and have provided the basis for a number of collective analyses, in which several studies are presented and compared (e.g., Steckel and Floud, 1997; Komlos and Baten, 1998).

Most studies in anthropometric history rely on adult stature, which is most strongly influenced by environmental factors during the first years of life (especially the first three years after birth). Even if there is a moderate influence also during teenage years, the birth decade is the usual category by which historical height evidence is organised, and this convention is also used in this chapter.[3] This has the implication that the time series presented

[2] The term "biological standard of living" was coined by Komlos in 1985. One of the rare exceptions to the height-longevity correlation is that of the relatively short, because protein-deprived, Japanese prior to the economic boom of the 1960s; their longevity was above average, thanks to the high valuation of personal hygiene, the importance of which was underscored by health-related instruction in the schools.

[3] This implies that adult height data for the cohort born in the 1960s should be confronted with indicators for other well-being dimensions referring to the 1960s because height reflects the health situation in the first years after birth and other well-being indicators (such as period-especific mortality) reflect the situation when they are measured.

here end in the 1980s, as not all persons born during the 1990s have reached their final adult stature yet.

What are the most important determinants of the biological standard of living? A population's average height is in large part a function of the disease environment and the availability of high-protein foodstuffs (chiefly meat and dairy products). The impact of high-quality proteins and calcium on anthropometric values has been described in terms of a bottleneck (Baten 2010). The bottleneck concept implies that other food items necessary for a balanced diet, such as fruits, vegetable or grains, were much more easily available, whereas protein was expensive to produce in densely populated areas over most of the period under study. The historical record indicates that humans have always needed large amounts of protein to generate the antibodies needed to fight infectious disease, and today's underdeveloped countries are no exception. Especially milk helps to create antibodies (Grigg, 1995, De Beer 2012)). Added to this protein effect is that of the disease environment, which is often approximated with of infant-mortality rates (Baten and Blum, 2012a and 2014).

This chapter will also compare height trends with GDP per capita, used as a measure of aggregate economic production. Countries with higher GDP are able to generate not only more high-quality foodstuffs but also, at least since the last century, more medical goods and services. However, a variety of issues may drive a wedge between economic production and the Biological Standard of living.

If historians are coming to use height as a valid complement to conventional welfare indicators, this is because it has some specific advantages. A given income level permits the purchase of a given quality as well as quantity of food and medical services, and is thereby correlated with health status, which in turn is correlated with height. However, this income-height correlation is not one-to-one, modified as it is by important inputs not traded in the marketplace but provided as public goods, such as infant-nutrition programs and public hospitals, which may lead to deviations between purchasing power-based and height-based measures of human well-being. Moreover, income measures fail to account for differences in people's command over resources within households. While it cannot account for every potential influence in a given population, the anthropometric approach permits economists and historians to capture important aspects of the biological standard of living (Komlos, 1985; Steckel, 1995), particularly in developing countries, which were hitherto neglected because of the lack of reliable data. The well-known Maddison data set (2001), for example, provides only rough estimates for per capita GDP in many such countries prior to 1910. While height is not without its deficiencies as a measure of the standard of living of a given population, it generates insights into global changes, and is particularly valuable as a countercheck as well as a complement to conventional indicators, permitting more reliable results than might otherwise be the case.

Historical sources

This sections provides a selective description of the more prominent studies on which our data set is based. Thanks to the existence of a considerable body of scholarly work, long-term time series are today available for a considerable number of countries around the world; however, in other cases, the available evidence remains limited. The availability of data varies among world regions, but over the past decade it has significantly increased. Western Europe and European settlements have been the object of numerous studies and other world regions of a few studies (e.g., Floud, Wachter and Gregory, 1990; Floud, 1994; Baten and Komlos, 1998; Steckel and Floud, 1997). Costa and Steckel (1997) combined all US studies in a trend estimate that is based on a number of individual studies using data from the military and prison records for the 19th century (see also Zehetmayer, 2011). More recently, Southern Europe has been added to the data set (A'Hearn, 2003; Pesacchi, 2008; Martínez-Carrión, 1994). Garcia and Quintana-Domeque (2007) and Hatton and Bray (2010) extended the European data set, while Whitwell, de Souza and Nicholas (1997) have provided evidence for Australia.

Evidence for both Eastern Europe and Central Asia has been provided by Mironov (1999, 2004) thanks to a combination of archival and contemporary anthropological data (see also Mironov and A'Hearn, 2008). Mironov's estimates of Russian and various other Eastern European height data provide a valuable overview of this world region, even if Wheatcroft (1999) has offered a different interpretation. Data for central Asia can be drawn from the so-called demographic and health surveys (DHS) conducted from the 1980s onward that allow to cover birth decades after the 1940s, whereas anthropologists have provided data for the birth period 1960-89 in Eastern Europe (e.g., Bielicki and Hulanicka, 1998; Vignerova and Blaha, 1998). Among Komlos' many studies are several on those regions of south-eastern Europe that once composed the Habsburg Empire (1985, 1989, 2007). Kopczyński has done likewise for Poland (2006).

For pre-1950 Latin America, data on Argentina and Colombia -- mainly based on prisoner lists, military and especially passport samples -- have been provided by Salvatore (1998, 2004), Salvatore and Baten (1998), López-Alonso and Porras (2003), Meisel and Vega (2004a, 2004b), Carson (2005, 2008), and recently Baten and Carson (2010). Brazil, Peru, and Argentina have been recently studied by Baten, Pelger, and Twrdek (2009) and Twrdek and Manzel (2010). In addition, there is scattered information regarding the Indian populations in these and other countries (Bogin and Keep, 1998).

India, Asia, the Middle East, and North Africa are only modestly documented. We have access to Indian height data for the early 20th century (Guntupalli and Baten 2006) but also for birth cohorts dating as far back as the early 19th century (Brennan, McDonald, and Shlomowitz, 1994a, 1994b, 1997 and 2000). Although the latter studies are based on labour-migrant heights, which are not necessarily a representative sample of India's population, the authors offer persuasive arguments that these heights estimates were equivalent to those of the population as a whole. For Japan, evidence is provided by Mosk (1996), Bassino (2006), Shay (1994) and Honda (1997), while for China estimates are available through Morgan (2006), Baten and Hira (2008) and Baten, Ma, Morgan and Wang (2010). The latest of several studies of Korea is one for North Korea by Pak, Schwekendiek and Kim (2010). As for Southeast Asia, a modest amount of data on this region is available (Bassino and Coclanis, 2008, for Myanmar/Burma; van der Eng, 1995, Baten, Stegl, and van der Eng 2009 for Indonesia: Murray, 2002, for the Philippines). Estimates for the Middle East and North Africa in the late 19th and early 20th centuries have been provided by Stegl and Baten (2009). Data from the Demographic and Health Surveys (DHS) program allow computing a trend estimate for Turkey and Egypt during the period 1950-89, while the 1970s and 1980s have been the object of a number of anthropological studies.

African height data on freed slaves and military recruits permit a rough estimate for the early 19th century (Eltis, 1982; Austin, Baten and van Leeuwen, 2012). Eltis (1982) argued that the height discrepancy between freed slaves and others was negligible, because height was not an important pricing criterion; while slave heights varied from region to region, regional prices did not reflect this variation. Furthermore, any height differences among freed slaves were diminished by Africa’s own demand for the strongest (and thus presumably the tallest) workers available, because Africa was a labor-scarce world region herself. At the same, there is no evidence that the slave market established anything like the military's minimum-height requirement. A comparison of soldiers' and slaves' height data indicates that the latter did not suffer from significant bias (Austin, Baten, and van Leeuwen, 2012). For Africa during the period 1890-1930, a large number of anthropological studies are available: for example, estimates for the two major Kenyan peoples, the Kikuyu and the Massai (Orr and Gilks, 1931), as well as recent studies for a broader set of population groups (Moradi, 2009a; Austin, Baten and Moradi, 2008). The problem of potential survivor bias in the African DHS data sets, which span the years 1945-89, has been addressed and resolved by Moradi (2005).

As a result of all these studies, the coverage of height estimates for almost all countries in the world is quite comprehensive (Baten and Blum, 2012a) and for many countries, continuous time series are available.

Comparability issues and data limitations

Depending on the type of historical sources used, a number of methodological issues needs to be considered. How can we estimate the world height trends over a period spanning nearly two centuries? Needless to say, in some cases height estimates are compromised by regional selectivity biases and other factors. The estimates presented in this chapter have been collected being as accurate as possible under the present circumstances, recording height by province whenever possible, and adjusting calculations to take into account any modifications of national borders.

Only certain combinations of countries and birth decades are sufficiently well documented to contribute to our estimates; for instance, no evidence is available for the Middle East and North Africa in the early 19th century, in large part because of the absence of precise height measurements in Ottoman Empire military data, which categorized each recruit as small, medium, or large -- and barefaced or bearded. In most other world regions, however, army data are available for the early 19th century.

The year 1950 marks a turning-point in that, from that moment on, population censuses, health surveys, and similar sources include height data on women -- in fact, considerably more than on men -- because institutions other than the military, particularly those related to the health sciences, begin to take interest in them. The fact that there is a correlation, if not a simple one, between men and women heights is by now beyond dispute (Baten and Murray 2000, Moradi and Guntupalli 2014) and it justifies our substituting one set for another when need be. Objections to this strategy might be raised by those who accept the female- resiliency hypothesis, which holds that for biological reasons the average height of a given female population is more resistant to adverse conditions than is that of their male counterparts. Some evidence from small pre-historic samples supported this hypothesis. However, drawing on the largest height sample available to date, Guntupalli (2005) has gone far to disprove this hypothesis for the last two centuries. Since the vast majority of historical height estimates are for men, we transform all estimates into male equivalents, estimating specific regression equations for each world region in order to account for potential differences (Baten and Blum, 2012).[4]

To construct this database, we have taken great care to identify all the biases that may have been generated by the institutional context -- enlistment in the military, incarceration in prisons, and sale in the slave trade, chiefly -- in which heights were recorded.[5] Estimates from voluntary soldier samples were included in the database only if satisfactory statistical methods had been used by the researchers who collected such data to eliminate the height bias of truncated samples.[6]

---

[4] It is also reasonable to assume that a teen-age conscript from a malnourished population has yet to reach his maximal height. In such a case, we calculate what their height will be when reaching adult age by applying the method presented in Baten and Komlos (1998). See the notes to Table 1 in Baten and Komlos (1998). These authors suggested the following adjustments, derived from Mackeprang's 19th-century-growth studies, for societies in which men in their teens and twenties have yet to achieve their maximal height (as a rule, above 170 cm): those who were 18 years of age, were estimated to have 2.4 cm to go; those age 19, 1.7 cm; those aged 20, 0.9 cm; those aged 21, 0.4; and finally those aged 22, only 0.1 cm. Clearly these estimates are not valid for all populations, since growth in late adolescence is largely a function of the individual's environment, but without such simplification comparison of heights in this age group would be impossible. The results presented in Table B.1 of the appendix indicate that these estimates are generally valid.

[5] The database here presented were also corrected, to the extent possible, for other types of social, ethnic, and regional biases.

[6] One could imagine that height samples based on volunteer army records might also be affected by another type of sample selectivity: in fact, the preference for joining the military as an income opportunity will declined in times of war (or periods of expected war events), and it might increase in times of high unemployment and low relative wages in the civilian sector. With respect to the first factor, , this is because better off (and taller) people might have avoided the risk of being killed in a war, hence they did not join the army during this period, whereas in peacetimes some well-off people might have considered the army; this implies that the relative preference in wartimes might have differed depending on whether a potential recruit came from a well-off family background and received a relatively good education (and happened to be tall because of that). With respect to the second factor, the social composition of those joining a voluntary army might have differed between prosperous and depressed periods. Among the poorer and less educated strata, a certain share might have always joined the army, whether economic situation was good or bad. The wages might have been perceived as sufficient, and unskilled mining or building jobs were sometimes also dangerous for one's health. Conversely, among the wealthier strata, one could imagine a higher share might have joined the army during bad times,, because civilian jobs were less easy to obtain and poorly paid. In better times, a lower share might have been willing to enlist, because of the additional hazards and tough hierarchic structures of army life. Somewhat similar arguments could be made about becoming a criminal (more educated and taller individuals might commit a crime in times of high unemployment and poverty). Fortunately, less than ten percent of global height samples in our database were derived from volunteer army or prison records. Height series which had to be estimated based on this type of sources were in most cases carefully examined by comparing height series from other institutional contexts, or

As for those institutional contexts that are specific to certain world regions and time periods, Baten and Blum (2012) have included them in a series of bias-analysis regressions, each designed to expose a potential bias typical of a given region or time period. For example, the estimates used here rely partially on prison samples for Latin America and North America in the 19th century, whereas those for most European countries are based on conscript samples, which as a rule cover a broader portion of the social spectrum; and anthropological samples were virtually the sole source for certain world regions. In order to assess the impact of potentially unrepresentative data sets, Baten and Blum (2014) have produced estimates including and excluding those: differences were, in most cases, negligible.

Self-reported heights are particularly prevalent in western countries in the later 20th century. Since, according to a number of studies, men tend to overestimate their own height, the corrective recently proposed by Hatton and Bray (2010), which Baten and Blum (2012) have tested for its accuracy, has been adopted here.

In the case of data for the Middle East and Africa, a drawback of early anthropological studies is that the importance of identifying individuals by birth cohort was not yet understood, as it was assumed that the physical measurements of a given population did not evolve from one decade to the next. The result is that, when using on anthropological data, Baten and Blum (2012a) had to approximate birth decades, and accept the possibility that a small proportion of those individuals identified as belonging to a given cohort in fact belonged in one of the two adjacent ones.[7]

---

some other information in the sources (occupational structure, literacy, numeracy) was compared to census records of the time, in order to assess the degree of representativeness of the samples considered. In order to mitigate the effects of labour markets at the time of recruitment (or war risk), anthropometric historians have used samples taken only in one or very few years that were homogenous in terms of labor market and military situation. As for other potential biases, one way to estimate their possible effect is to regress stature on a full set of birth decade and country dummy variables.

[7] Koepke and Baten (2005, 2008) and Stegl and Baten (2009) estimated average heights in such cases by using a large number of studies that reflect in sum the changes over time, because if a study was done in the 1940s, the birth decades of mostly the 1910s were covered, and if a study was done in the 1960s, the birth decades of the 1930s could be covered and so on. It should also be noted that time trends that result from such estimations resemble moving averages in that they smooth out the evolution of height averages. For example, if there was a height decline among a given population during the 1880s, but only 70% of the individuals in the data set

When Baten and Blum (2012a) regressed human stature on a full set of country and birth-decade dummies and on those potential-bias variables, all coefficients of the latter variables turned out to be statistically insignificant.[8]

The question of what role genetics, as well as nutrition, may play in determining a given population's average height was often raised in the early years of anthropometric research (Blum 2013). It turns out that, while genes are a key determinant of an individual's height, genetic deviations from the mean cancel each other out when analysis groups of individuals. Moreover, there is considerable evidence that it is environmental conditions, not genes, which account for today's height gap between rich and poor populations, including those inhabiting a single nation. Habicht et al. (1974), for example, found that the height gap between the rich and poor populations in Nigeria was even wider than that between high-ranking groups in a typical low-income country and in the United States.[9] Similar conclusions were reached by Fiawoo (1979), in his study of Ghana, Eksmyr (1970), based on data on several Ethiopian ethnic groups, and Graitcer and Gentry (1981), who studies Egypt, Haiti, and Togo. The height-distribution for children from rich families in Graitcer and Gentry (1981) are also in line with those for the United States. Of course, not all height differentials are due to environmental conditions: African bushmen and pygmies, for example, spring to mind but these groups account for only a small percentage of their respective nations' populations.

However, the evidence presented here on Africa has potential for improvement, because the estimates sometimes relied on small numbers of cases for the early period, and typically on only one institutional context (such as measurements of slaves, prisoners,

---

belonged to the 1880s cohort (the remaining 30% having been born in the previous one), the decline would appear to be smoother than, in fact, it was.

[8] The coefficients were also small in most cases, with the exception of the coefficient for slave-based samples, which was however statistically insignificant. Thus it may very well be in this special case of slaves that an insufficient amount of data, for the purposes of comparisons, accounts for the large coefficient. For other anthropometric studies, a very important result is that prisoners and voluntary soldiers did not differ significantly from other height sources, because this had been an issue in many earlier studies.

[9] The following review of the literature is based on Moradi and Baten (2005).

military, anthropological studies). Conversely, in other world regions, we can often compare evidence from different institutional contexts, which reduces the likelihood of measurement error. For example, early South African evidence comes from Xhosa laborers who worked as temporary laborers on Western Cape farms. This may lead to an upward bias, if only the most healthy and strong individuals were accepted as laborers (even if Brennan et al. 1994a, 1994b, 1997, 2000 argued that this bias was not strong in the South Asian case).

Table 1 provides a snapshot assessment of the main factors affecting the quality of the height indicators used here. The table relies on slightly different criteria – relatively to other chapters in this report-- to create four classes of data, because height was never a part of official statistical reporting:

- Institution data: evidence is the product of international institutions such as the Demographic and Health Surveys and the Eurostat compilations, which aimed at high standards of representativeness of their sampling procedures.
- High quality data: the product of economic-historical research that assessed the possibility of sample-selection bias in the sources using secondary characteristics (such as comparing occupational structure of samples with occupational structure of representative censuses, and reweighting samples to become representative), or which relied on sources that are unlikely to be affected by sample selection bias.
- Moderate quality data: estimates from historical research that relied on sources which could be affected by sample selection biases, or that made use of indirect data and estimates.
- Low quality data: estimates based on guesses, conjectures and interpolation between benchmark years.

It should be noted that Table 1 reports averages. In some world regions, some countries might have had weaker data.

Trends in the data over time and across countries

Figure 1 and Table 2 show adjusted height estimates of world-regions for the entire 1810s-1980s period based on the population-weighted averages of 156 countries (Baten and Blum, 2012b). Several groups of world regions can be distinguished:

(1) The Western offshoots had very high anthropometric values for much of the period under study. Height in these countries declined towards the level prevailing in other regions until the late 19th century, then started to grow again.

(2) Both Western Europe and those countries in Eastern Europe that experienced socialist rule recorded a strong upward trend in average height after the 1880s. However, once the U.S.S.R. came into being the height gap between Western and Eastern Europe increased (Komlos 1999, Mironov 2006). In contrast, average height in Latin America, the Middle East, and North Africa was at relatively high levels in the 19th century but it experienced only modest increases during the 20th century (Salvatore 2004).

(3) East Asia and Sub Saharan Africa remained throughout the entire period near the global average, with the exception of East Asia during the late 19th century, where average height was significantly lower. Africa is the only world region in which the average height has steadily declined over the last two decades (Moradi 2005).

(4) Finally, average height in South and Southeast Asia remained at a low level throughout the period under study. While no upward trend of any significance occurred in South Asia since the end of the 19th century, Southeast Asia experienced a slight upward trend; at the start of the period, average height in this region was even lower level than were those of its neighbours (Brennan, McDonald, Shlomowitz, 1994a, 1994b, 1997 and 2000; Guntupalli and Baten, 2006; Baten, Stegl and van der Eng, 2010). In sum, after the 1880s, global heights increased on average, but also became more unequal.

Some country developments are particularly interesting and are discussed below (see Appendix Table A1 on height trends in 25 countries). In the Americas, between-country differences of stature were particularly pronounced. Mexico displayed the shortest level of just over 160 cm in the early 19th century, followed by Brazil. On the top end of the spectrum, the United States, Canada and Australia were leading in anthropometric values, also worldwide. North Americans and Australians born in the New World were much taller than the European population from which they originated, thanks to with abundant food supply. Argentina's anthropometric level was initially similar to the Western offshoots, but when population density grew, heights in Argentina declined slightly, converging to Brazilian heights around 1900. Various countries in the region experienced declining heights during the 1880s and 1890s.

Previous studies suggested two different explanations applying to late 19th century height decline in different world regions, namely the Americas, Africa and Asia. In the Americas, immigration and rapid population growth reduced the available protein per capita (and inequality was growing, with negative health effects). In addition, urbanization sometimes led to worsening disease environment. In Asia and Africa, in contrast, a wave of cattle plague was probably the most important force leading to lower average height (Stegl and Baten 2009, Baten et al. 2010), although other factors also contributed. With respect to the most recent period, Komlos (2009) argued that the height-advantage in the United States, relative to Europe, declined, while the gap between black and white US residents increased. In the case of black US women, their height declined – relative to white women -- by 1.42 centimeter during the 1980s; black US women were shorter than Western European women, including the Spanish and Italian ones (Komlos 2009).

Average heights in Asia (including the Asian part of Turkey) displayed less variation than in the Americas. Turkey and China topped the height-league in the region, with Turkey losing its prime position to China around the mid-20th century. At the lower end, Indonesia and Japan recorded the lowest height, although in Japan heights increased dramatically over the 20th century, reaching a joint top position with China in the 1980s. The tremendous growth in average height in Japan and the partial globalization of its cuisine might have contributed to this spectacular growth. India and Thailand took middle positions in Asia.

Finally, Europe started short and ended very tall. Only the richest country, the United Kingdom, had high anthropometric levels in the 1810s and 1820s, but when industrialization and urbanisation reached its maximum speed around the mid-19th century, the British became also short, at least relative to US Americans of English ancestry. Scandinavia (Sweden in the Appendix Table A1) had the lead in most of the period, but the Dutch took over after their welfare state expanded and after it became technologically feasible to transport high quality protein (contained in milk for example) to such a densely settled country in high quantities.

These technological possibilities were lacking in Southern Europe (Italy, Spain) until much later. Only over the last half century, young Spaniards and Italians became almost as tall as other Europeans. In general, Europe started its dramatic height increase after the 1870s and 1880s and this increase included the East (Poland, Russia) as well as the West. Northwestern Europe (including Germany) was always slightly ahead, according to this indicator – but far behind the New World in the early 19th century.

Correlations with GDP per capita

Height and GDP are complementary measures of the standard of living. GDP per capita is a measure of the value of final goods and services produced within a country in a given time-period and captures the aggregate production of the economy, whereas height is more closely correlated with nutrition and health care. While their correlation was initially stressed in the literature (Fogel et al., 1982), evidence over the past two decades indicates that they should be regarded as indicators that sometimes do not move in parallel. Significant deviations have been found not only between average height and GDP but also between height and real wages for unskilled labor (Margo and Steckel, 1983; Komlos, 1998). However, these findings are based largely on UK and US data, and the correlation between real wages and heights was much closer in most other countries (Baten, 2000).

The scattergrams for the whole period, and for the 1910s and the 1980s separately indicate positive correlation between real GDP per capita on the horizontal and average height on the vertical axis (Figure 2 and 3). The bulk of observations is clustered between 160 and 180 cm, indicating that height averages are located in this range throughout the period under study. There are only a few cases at the low end of the scale, between 155 and 160 cm (mostly in East and Southeast Asia), and above 180 cm at the high end. Japanese values are somewhat lower than expected from its GDP. But even the Japanese observations are not outliers in this global sample (for example, they are less than two standard deviations away from the regression line).

Jamaica displays higher anthropometric values than GDP per capita in the 1910s (Figure 3). This result is interesting, because Jamaica is often cited as an example for an early achiever of high life expectancy, despite its low income level (see the health chapter in this volume). The Biological Standard of living in Jamaica has entered the literature as “The Jamaica Paradox” (Riley, 2005). Riley wondered why Jamaica had a relatively high life expectancy in spite of its low income per capita. The fact that the majority of the Jamaican population had African slaves ancestors also did not encourage to expect a high life expectancy, because on other Latin American countries the regions of high former slave concentrations (Brazil’s Northeast and Colombia’s low lands) typically had low levels of welfare. However Jamaica differed in some important points. First, some aspects of the British educational system which provided basic literacy survived in its previous colonies: with basic literacy and numeracy, health-related behavior is usually better developed. Riley also noted that the government invested substantially in public health, extending access to poorer people. Another factor that may explain the Jamaica Paradox was the relatively high gender equality: previous French and English colonies in the Caribbean had a remarkably similar level of basic numeracy for both genders. Osmani and Sen (2003) have argued that gender equality is an important determinant of the health status of the next generation. In most societies, women have a large impact on child care, as well as children's health and education. For height – and for longevity, before countries reach a certain level of GDP per capita and world market integration – the proximity to protein is also an important advantage. Jamaica had a substantial cattle per capita – at least the rates were many times higher than in most Asian countries of the same income level.

If we consider three other examples - - Norway, with higher heights; Italy and Vietnam with lower heights than expected from GDP values - - the latter two determinants of health might have similar effects: Norway had substantial proximity to protein production, and gender inequality was traditionally low (partly because women had an active role in dairy farming). By contrast, in both Italy and Vietnam, gender inequality was substantially higher, and cattle per capita numbers were low during the late 19th century.

If we compare the correlations between average height and GDP per capita over time, we have to take care that the number of observations is not becoming too small (Figure 4). Before 1870, and for the 1880s and 1890s, the number of countries for which both height estimates and GDP estimates are available, is below 30, making statistical inference questionable. This may explain the fact that correlations before 1870s are smaller than afterwards. After the 1870s, the correlation is always around 0.6 to 0.8. During the 20th century, the closest correlation occurs during the 1940s, i.e., the most disrupted period for the world economy. One possible explanation is that the biological standard of living during this decade depended mostly on country-specific resources and productive capacity, whereas in the post-war period, transfers of resources and knowledge about medical technologies played an increasing role in mitigating the income-health relationship.

Heights can also be used to study the inequality between countries in the world economy. How did inequality between a sample of 25 large countries develop (for the definition of this group, see Appendix Table A1)? Figure 5 shows the coefficient of variation between countries, which is a standard measure for measuring dispersion between countries (O'Rourke and Williamson, 1999), countries are weighted by their population size. In general, the trend of height inequality between countries is clearly upward from the 1870s to the 1970s (the line with diamonds in Figure 5). If we compare the dispersion of GDP levels for the same period, the trend is very similar (the rectangles in the same Figure). However, the volatility of GDP dispersion is slightly larger in the 19th century than in previous periods.[10] In general, the 1940s and 1950s represent the period of most rapid increases of inequality for both height and income. In spite of WWII, it was a period of diffusion of medical and hygienic knowledge. Also the quality of nutrition could be improved in the Western offshoots as well as in Eastern and Western Europe due to the diffusion of fertilizer and agricultural machinery technology. But in general, the 20th century height increase in the richer countries can be attributed to health rather than to nutritional improvements. In contrast, the large countries of the developing world experienced particularly difficult times in the 20th century. For example, China suffered particularly from military conflicts and institutional changes, while India suffered from those factors as well as from the civil wars between religious groups.

The GDP dispersion suggests that the 1980s were the turning point to much less between-country inequality. The 2000s display a coefficient of variation among those 25 countries which was as low as it had never been in the 20th century before. Conversely, when using the interpolation method suggested by Baten and Blum (2012a, 2012b) for the early 19th century, we find that anthropometric dispersion did not change very much during the 1810s to 1870s period.[11]

---

[10] For the 1870s, GDP estimates are available for 21 countries, but for the 1880s only for 16 (including a number of poorer countries).

[11] To compensate for such missing values, we applied the best possible interpolation strategy: wherever possible, we identified a benchmark level estimate for each country that allows obtaining levels close to true height values for the country to be interpolated. We then used the variation over time of other, nearby countries with similar characteristics. Linear interpolation was to be avoided, because of the risk that it might obscure certain fluctuations: for instance, declines that occurred in certain countries during the second half of

Priorities for further work in the area

What should be the priorities for the study of human stature as a development indicator in the future? The greatest potential probably lies in extending the existing evidence back to preindustrial and ancient times. Steckel and Rose (2002) as well as Koepke and Baten (2005 and 2008) have pioneered the use of long bones for reconstructing height trends in those early periods of human development. The potential for mobilizing additional data in this field is large. For example, the rapid construction of highways in China over the last decade required a large number of archeological excavations. It seems that a large number of human bones was simply stored in buildings next to the highways and await more detailed analysis. Other countries in the Middle East, Central Asia, Eastern Europe or Southern Africa have similarly great potential for anthropometric analysis; both the tropics and subtropics might provide samples of long bones to study.

Another priority for further research could be to develop an inequality measure based on long bone data, if income inequality measures to calibrate and compare those can be developed. Apart from these projects for the premodern period, a number of gaps should be addressed by future research, such as the study of heights in the Middle East for the early 19th century or clarifying the selectivity of slaves relative to the population from which they were captured.

Finally, several gaps could be filled by developing a good model for height selectivity of migrants. To which degree were migrants similar in height to the population from which they originated? If they were different, were the determinants of positive or negative height selectivity similar to the migrant selectivity of education (Borjas, 1987; Stolz and Baten,

the 19th century. Instead, we opted for backward- and forward-projection techniques, using the country-specific benchmark years and obtaining the changes between benchmark and estimated decades from a similar and neighboring country. For example, the change from the 1870s to the 1880s in Iraq is more similar to the change in Iran over the same period, than one would conclude from the results of a linear interpolation in Iraq between 1870 and 1890. Keeping the height level with the 1870 Iraq benchmark guarantees its accuracy.

2012)? Finally, studies on regional differences of height are required in the future, especially for the developing world. While this chapter focused on national averages, regional variation within countries can sometimes be as large as international differences.

References

A'Hearn, B. (2003): Anthropometric Evidence on Living Standards in Northern Italy, 1730-1860. Journal of Economic History 63, pp. 351-381.

Austin, G., Baten, J. and van Leeuwen, B. (2012): The biological standard of living in early nineteenth-century West Africa: new anthropometric evidence for northern Ghana and Burkina Faso. The Economic History Review 65(4), 1280-1302

Austin, G., J. Baten, and A. Moradi (2008): Exploring the evolution of living standards in Ghana, 1880-2000: An anthropometric approach. Working paper, London School of Economics /Tuebingen/Oxford.

Bassino, J.-P. (2006): Inequality in Japan (1892-1941): Physical Stature, Income and Health. Economics and Human Biology 4 (1), pp. 62-88.

Bassino, J.-P. and Coclanis, P. (2008). Economic transformation and biological welfare in colonial Burma: Regional differentiation in the evolution of average height. Economics and Human Biology 6(2), 212-227.

Baten, J. (2000). Heights and real wages in the 18th and 19th centuries: an international Overview, Jahrbuch fuer Wirtschaftsgeschichte 2000-1, pp. 17-32.

Baten, J. and M.Blum (2012a): Growing Tall but Unequal: New Findings and New Background Evidence on Anthropometric Welfare in 156 Countries, 1810-1989. Economic History of Developing Regions 27(1)

Baten, J. and M.Blum (2012b): An Anthropometric History of the World, 1810-1980: Did Migration and Globalization Influence Country Trends? Journal of Anthropological Sciences 90

Baten, J. and M.Blum (2014): “Why are you tall while others are short? Agricultural production and other proximate determinants of global heights”, *European Review of Economic History* (forthcoming 2014).

Baten, J. and Carson, S. A. (2010): Latin American anthropometrics, past and present – An overview. Economics and Human Biology 8(2), pp. 141-144.

Baten, J. and Hira, S. (2008): Anthropometric Trends in Southern China, 1830-1864. Australian Economic History Review 48 (3), pp. 209-226.

Baten, J. and Komlos, J. (1998): Height and the Standard of Living. Journal of Economic History 57 (3), pp. 866-870.

Baten, J., D. Ma, S. Morgan, and Q. Wang (2010): Evolution of Living Standards and Human Capital in China in the 18-20th Centuries: Evidences from Real Wages, Age-heaping, and Anthropometrics. Explorations in Economic History 47 (3): pp. 347-359.

Baten, J., and Murray, J. (2000). Heights of Men and Women in Nineteenth Century Bavaria: Economic, Nutritional, and Disease Influences, Explorations in Economic History 37, pp. 351-369.

Baten, J., I. Pelger, and L. Twrdek (2009): The Anthropometric History of Brazil, Lima (Peru), and Argentina during the 19th and early 20th Century. Economics and Human Biology 7-4, pp. 319-333.

Baten, J., M. Stegl and P. van der Eng (2013): The biological standard of living and body height in colonial and post-colonial Indonesia, 1770-2000. Journal of Bioeconomics 15 (2013): 103-122.

Bielicki, T., Hulanicka, B. (1998): Secular Trend in Stature and Age at Menarche in Poland. In Bodzar, B.E. and Susanne, C. (eds.) Secular Growth Changes in Europe. Budapest: Eötvös Univ. Press, pp. 263-279.

Billewicz W. Z. and McGregor, I. A (1982). 'A Birth-to-Maturity Longitudinal Study of Heights and Weights in Two West African (Gambian) Villages 1951-1975', Annals of Human Biology 9, no. 4, pp. 309-320.

Blum, M. (2013). Cultural and genetic influences on the “Biological Standard of Living”. *Historical Methods* 46(1), 19-30.

Bogin, B. and Keep, R. (1998): Eight Thousand Years of Human Growth in Latin America: Economic and Political History Revealed by Anthropometry. In: Komlos, J. and Baten, J. (eds): The Biological Standard of Living in Comparative Perspective Stuttgart: Steiner.

Borjas, G.J. 1987. “Self-Selection and the Earnings of Immigrants.” The American Economic Review 77/4, pp. 531-553.

Brennan, L., MacDonald, J. and Shlomowitz, R. (1994a): The Heights and Economic Wellbeing of North Indians under British Rule. Social Science History 18, pp. 271-307.

Brennan, L., McDonald, J. and Shlomowitz, R. (1994b): Trends in the economic well-being of South Indians under British rule: the anthropometric evidence. Explorations in Economic History 31, pp. 225–260.
Brennan, L., McDonald, J. and Shlomowitz, R. (1997): Towards an anthropometric history of Indian under British rule. Research in Economic History 17, pp. 185–246.
Brennan, L., McDonald, J. and Shlomowitz, R. (2000): Change in the stature of North Indians from British rule. Jahrbuch für Wirtschaftsgeschichte, pp. 129–148.
Carson, S.A. (2005): The Biological Standard of Living in 19th Century Mexico and in the American West. Economics and Human Biology 3(3), pp. 405-419.
Carson, S.A. (2008): The Stature and Body Mass of Mexicans in the Nineteenth-Century United States. The Journal of Interdisciplinary History 39 (2), pp. 211-232
Costa, D.L. and Steckel, R.H. (1997). "Long-term Trends in Health, Welfare, and Economic Growth in the United States," In Health and Welfare during industrialization, Richard H. Steckel and Roderick Floud (eds.). Chicago: University of Chicago Press.
De Beer, H. (2012). Dairy products and physical stature: A systematic review and meta-analysis of controlled trials *Economics and Human Biology* 10(3), 299-309.
Eksmyr (1970) Anthropometry in privileged ethiopian preschool children. Acta Paediatrica Scandinavica, 59, 157–163.
Eltis, D. (1982): Nutritional Trends in Africa and the Americas: Heights of African, 1819-1839. Journal of Interdisciplinary History 12, pp. 453-475.
Fiawoo, D. K. (1979). Physical Growth and the School Environment: A West African Example, in W. A. Stini ed., *Physiological and Morphological Adaptation and Evolution*, (The Hague, 1979), pp. 301-314.
Floud, 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. Chicago: University of Chicago Press, pp. 9-24.
Floud, R., K.W.Wachter and A.S. Gregory (1990): Height, health and history: Nutritional status in the United Kingdom, 1750-1980. Cambridge: Cambridge U. Press
Fogel, R.W., Engerman, S.L., and J. Trussell (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, pp. 401-421.
Fogel, R. (1994): Economic growth, population theory, and physiology: The bearing of long-term processes on the making of economic policy. *Am. Econ. Rev.*, 84,3, 369-395.
Floud, R., Fogel, R., Harris, B. and Hong, S.C. (2011): The Changing Body: Health, Nutrition and Human Development in the Western World since 1700, Cambridge University Press, Cambridge.
Garcia, J. and Quintana-Domeque, C. (2007): The evolution of adult height in Europe: a brief note. Economics and Human Biology 5, pp. 340-349.
Graitcer, P. and E. Gentry (1981): Measuring Children: One Reference for All. *The Lancet* 8 August 1981, 297-299.
Grigg, D. (1995): The Pattern of World Protein Consumption, Geoforum 26 (1), pp. 1-17
Guntupalli, A. (2005). Essays on Indian Anthropometric Development. Ph.D. disseration Dissertation, Univ. Tuebingen.
Guntupalli, A.M. and Baten, J. (2006): The Development and Inequality of Heights in North, West and East India, 1915-44. Explorations in Economic History 43 (4): pp. 578-608.
Habicht , J.-P., Yarbrough, C., Martorell, R., Malina, R. M. and Klein, R. E. (1974). Height and Weight Standards for Preschool Children: How Relevant Are Ethnic Differences?', *Lancet* 303, no. 7858, pp. 611-615.
Harris, Bernard. (1994). "Health, Height, and History: An Overview of Recent Developments in Anthropometric History." *Social History of Medicine* 7, 297-320.
Hatton, T. and B.E. Bray (2010): Long run trends in the heights of European men, 19th–20th centuries. Economics and Human Biology.
Hatton, T. (2013). How have Europeans grown so tall? *Oxford Economic Papers* (forthcoming, advance access).
Honda, G. (1997): Differential Structure, Differential Health: Industrialization in Japan, 1868-1940. In: Steckel, R. and Floud, R., (eds.) Health and Welfare during Industrialization. Chicago: University of Chicago Press.
Koepke, N. and Joerg Baten (2005). "The Biological Standard of Living in Europe During the Last Two Millennia,"
European Review of Economic History 9-1 (2005), 61-95.
Koepke, N. and Joerg Baten (2008). "Agricultural Specialization and Height in Ancient and Medieval Europe,"
Explorations in Economic History 45, 127-146.
Komlos, J. (1985): Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development in the Eighteenth Century. American Historical Review 90 (5), pp. 1149-61.

Komlos, J. (1998): Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution. The Journal of Economic History 58, 778-95
Komlos, J. (2009). Recent Trends in Height by Gender and Ethnicivity in the US in Relation to Levels of Income. NBER Working Paper 14635.
Komlos, J. and Baten, J. (2004): Looking Backward and Looking Forward: Anthropometric Research and the Development of Social Science History. in Social Science History, pp. 1-24
Komlos, J. Baten, J. (1998): The Biological Standard of Living in Comparative Perspective. Stuttgart 1998.
López-Alonso, M. and Condey, R.P. (2003): The Ups and Downs of Mexican Economic Growth: the Biological Standard of Living and Inequality 1870-1950. Economics and Human Biology 1-2, pp. 169-186.
Maddison, A. (2001): The World Economy: A Millennial Perspective. OECD, Paris.
Margo, R. and R.H. Steckel (1983): Heights of Native Born Northern Whites during the Antebellum Period. Journal of Economic History 43, pp. 167-74.
Martínez-Carrión, J.M.M. (1994): Stature, Welfare, and Economic Growth, in Nineteenth-Century Spain: The Case of Murcia. In J. Komlos (ed.) Stature, Living Standards, and Economic Development. Essays in anthropometric History. Chicago: University of Chicago Press, pp. 76-92.
Martorell, R. and Habicht, J.-P. (1985) 'Growth in Early Childhood in Developing Countries', in F. Falkner and J. M. Tanner eds., *Human Growth: A Comprehensive Treatise,* (New York), pp. 241-262.
Meisel, A. and Vega, M. (2005): The biological standard of living (and its convergence) in Colombia, 1870–2003 A tropical success story. Economic and Human Biology 5-1, pp. 100-122.
Mironov, B.N. (1999): New Approaches to Old Problems: The Well-Being of the Population of Russia from 1821 to 1910 as Measured by Physical Stature. Slavic Review 58 (1), pp. 1-26.
Mironov, B.N. (2004) Zhiznennyi uroven' Sovetskoi Rossii pri Staline po antropometricheskim dannym. In: Ekonomicheskaia istoria. Ezhegodnik. Moskva: ROSSPEN, 2004. S. 565-588. [B. N. Mironov, "The Nutrition Standard of Life in the Soviet Russia under Stalin on the Anthropometric Data," in The Economic History. A Year-book. 2004. Moscow: ROSSPEN, 2004, 565-588.: data on those measured 1927, born 1907. Author provided data.]
Mironov, B. and B. A'Hearn. (2008): Russian Living Standards under the Tsars: Anthropometric Evidence from the Volga. Journal of Economic History 68:3, pp. 900-929.
Moradi, A. (2005): Height, Political Violence and Economic Development in Africa 1950-2000, Ph.D. thesis Tuebingen, available on University Library Tuebingen server.
Moradi, A. and A. M. Guntupalli (2014). What Does Gender Dimorphism in Stature Tell Us
About Discrimination in Rural India, 1930-1975? *Gender Bias: Health, Nutrition and Work*.
Moradi, A. (2009a): Towards an Objective Account of Nutrition and Health in Colonial Kenya: A Study of Stature in African Army Recruits and Civilians, 1880–1980. The Journal of Economic History 69, pp. 719-754.
Morgan, Stephen (2006). "The biological standard of living in South China during the 19th century: Estimates using data from Australian immigration and prison records," Paper prepared for the Asia/Pacific Economic and Business History Conference, QUT, Brisbane, 16-18 February 2006.
Morgan, S. (2009): Stature and economic development in South China, 1810-1880. Explorations in Economic History 46(1), 53-69
Mosk, C. (1996): Making Health Work; Human Growth in Modern Japan, Berkeley: University of California Press.
Murray, J.E. (2002): Height and Weight of Early 20th Century Filipino Men. Annals of Human Biology 29 (3), pp. 326-333.
Nafziger, E. Wayne (2012): Economic Development. 5th Edition, Cambridge University Press
O'Rourke and Williamson 1999. Globalization and History. MIT Press Cambridge/MA.
Orr, J. B. and J. L. Gilks (1931): Studies of Nutrition: The Physique and Health of Two African Tribes. London, Medical Research Council, Special Report Series No. 155. (Thanks to A. Moradi for providing this report.)
Osmani, S. Sen, A. (2003): The hidden penalties of gender inequality: fetal origins of ill-health. Economics and Human Biology 1 (2003) 105–121.
Pak, S., Schwekendiek, D. and Kim, H.K. (2010): Height and Living Standards in North Korea, 1930s-1980s. Economic History Review (forthcoming)
Peracchi, F. (2008): Height and Economic Development in Italy, 1730-1980. American Economic Review, 98(2): pp. 475–81.
Riley, J.C. (2005): Poverty and Life Expectancy: The Jamaica Paradox. Cambridge: Cambridge University Press.
Salvatore, R. and J. Baten (1998): A Most Difficult Case of Estimation: Argentinian Heights, 1770-1840. In J. Komlos and J. Baten, (eds.) The Biological Standard of Living in Comparative Perspective. Stuttgart: Franz Steiner, pp. 90-96.
Shay, T. (1994): The level of Living in Japan, 1885-1938: New Evidence. In: Komlos, J. (ed.) Stature, Living

Standards, and Economic Development: Essays in Anthropometric History, Chicago: University of Chicago Press.

Singer, J. David and Melvin Small (1972): The Wages of War, 1816-1965: A Statistical Handbook. New York. Or see http://www.correlatesofwar.org last accessed March 31st, 2010.http://www.systemicpeace.org/polity/polity4.htm#top

Steckel R.H. and R. Floud, eds. (1997): Health and Welfare during Industrialization. Chicago: University of Chicago Press.

Steckel, R. (2009): Heights and human welfare: Recent developments and new directions. Explorations in Economic History 46, pp. 1-23.

Steckel, R., and Rose, J. (2002), *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Cambridge: Cambridge University Press.

Stegl, M. and J. Baten (2009): Tall and Shrinking Muslims, Short and Growing Europeans: an Anthropometric History of the Middle East, 1840-2007. Explorations in Economic History 46 (2009), pp. 132-148.

Stolz , Y., Baten, J. (2012). Brain Drain in the Age of Mass Migration: Does Relative Inequality Explain Migrant Selectivity?", Explorations in Economic History 49 (2012), pp. 205-20.

Twrdek, L. and K. Manzel (2010): The seed of abundance and misery: Peruvian living standards from the early republican period to the end of the guano era (1820–1880). Economics and Human Biology 8 (2), pp. 145-152.

Vignerová, J. and Bláha, P. (1998): The Growth of the Czech Child During the Past 40 Years. In: Bodzar, B.E. and Susanne, C., eds., Secular Growth Changes in Europe. Budapest: Eötvös University Press, pp. 263-279.

Wheatcroft, S.G. (1999): The great leap upwards: anthropometric data and indicators of crises and secular change in Soviet welfare levels, 1880–1860. Slavic Review, 58 (1), pp. 27–60.

Whitwell, G., de Souza, C. and Nicholas, S. (1997): Height, Health, and Economic Growth in Australia, 1860-1940. In: Steckel, R.H. and Floud, R. (eds.) Health and Welfare during Industrialization. The University of Chicago Press, pp. 379-422.

Zehetmayer, M. (2011): The continuation of the antebellum puzzle: stature in the US, 1847–1894. European Review of Economic History 15(2), 313-327

Table 1: Average quality assessment of height values, by decades

	Western Europe (WE)	Eastern Europe (EE)	Western Offshoots (WO)	Latin America and Caribbean (LA)	Sub-Sahara Africa (SSA)	Middle East and North Africa (MENA)	East Asia (EA)	South and South-East Asia (SSEA)
1820	2	2	2	3	4		3	
1870	2	2	2	2	3	2	3	3
1913	2	2	2	2	3	2	3	2
1950	1	2	1	1	1	2	1	2
1973	1	2	1	1	1	2	1	2

Notes: With this table we provide a snapshot assessment of the main factors affecting the quality of the indicators. We have to apply slightly different criteria to create four classes of data, because height was never a part of official statistical reporting:

1. International institution data: evidence is the product of International institutions such as the Demographic and Health Surveys and the Eurostat compilations, which aimed at high standards of representativeness of their sampling procedures.

2. High quality: the product of economic-historical research which assessed the possibility of sample-selection bias in the sources using secondary characteristics (such as comparing occupational structure of samples with occupational structure of representative censuses, or using numeracy for the same purpose, and reweighting samples to become representative), or which relied on sources that are unlikely to have had sample selection bias.

3. Moderate quality: economic historical research, but relied on sources which could contain sample selection bias, or making use of indirect data and estimates.

4. Low quality: guesstimates, conjectures, interpolation between benchmark years.

Table 2: Average stature by region, 1820-1990. File: g:\a\ci\hgtreg.csc

decade	W. Europe	East. Europe and form. SU	W. Offshoots	Latin America and Carib.	East Asia	South and South-Eas Asia
1820	165.6	162.6	172.1	161.8	164.6	
1830	165.2	163.4	173.3	162.1	164.8	
1840	164.8	164.2	172	162.9	165.2	16
1850	164.6	164.1	171.2	163.2	165.2	16
1860	165.3	164.5	170.7	163.4	164.8	16
1870	165.9	165.9	171.1	164.2	164.9	
1880	166.6	166.5	169.7	164.5	164.4	16
1890	167	167.6	169.3	164.9	163.3	16
1900	168	168.3	170.1	165.1	163.4	
1910	169	168.8	172.1	165.2	164.1	16
1920	170.1	168.6	173.1	165.2	163.8	16
1930	171.3	169.6	173.4	166.3	165.9	16
1940	172.6	170	175.9	166.8	166.8	16
1950	174.5	172	177	167.3	168.5	16
1960	176.3	173.2	177.3	168.1	169.5	16
1970	176.8	174.8	178.3	169.4	169.8	16
1980	177.5	175.1	179	169.9	171.6	16

Sources: see text

Figure 1: Height by world regions, file: \a\ci\ghtreg.pdf

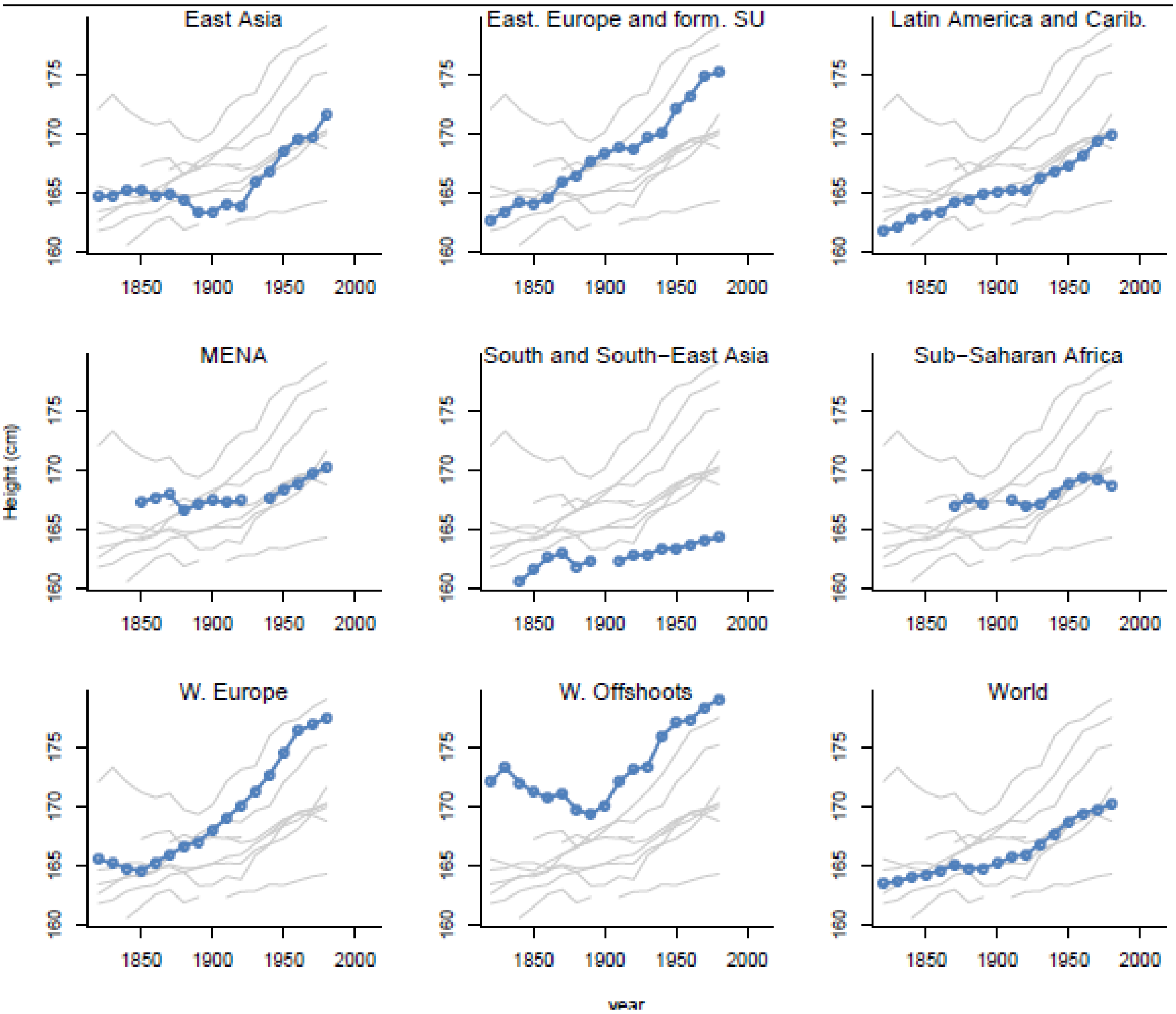


Figure 2: Height and GDP per capita, file: \a\ci\hgtcor.pdf

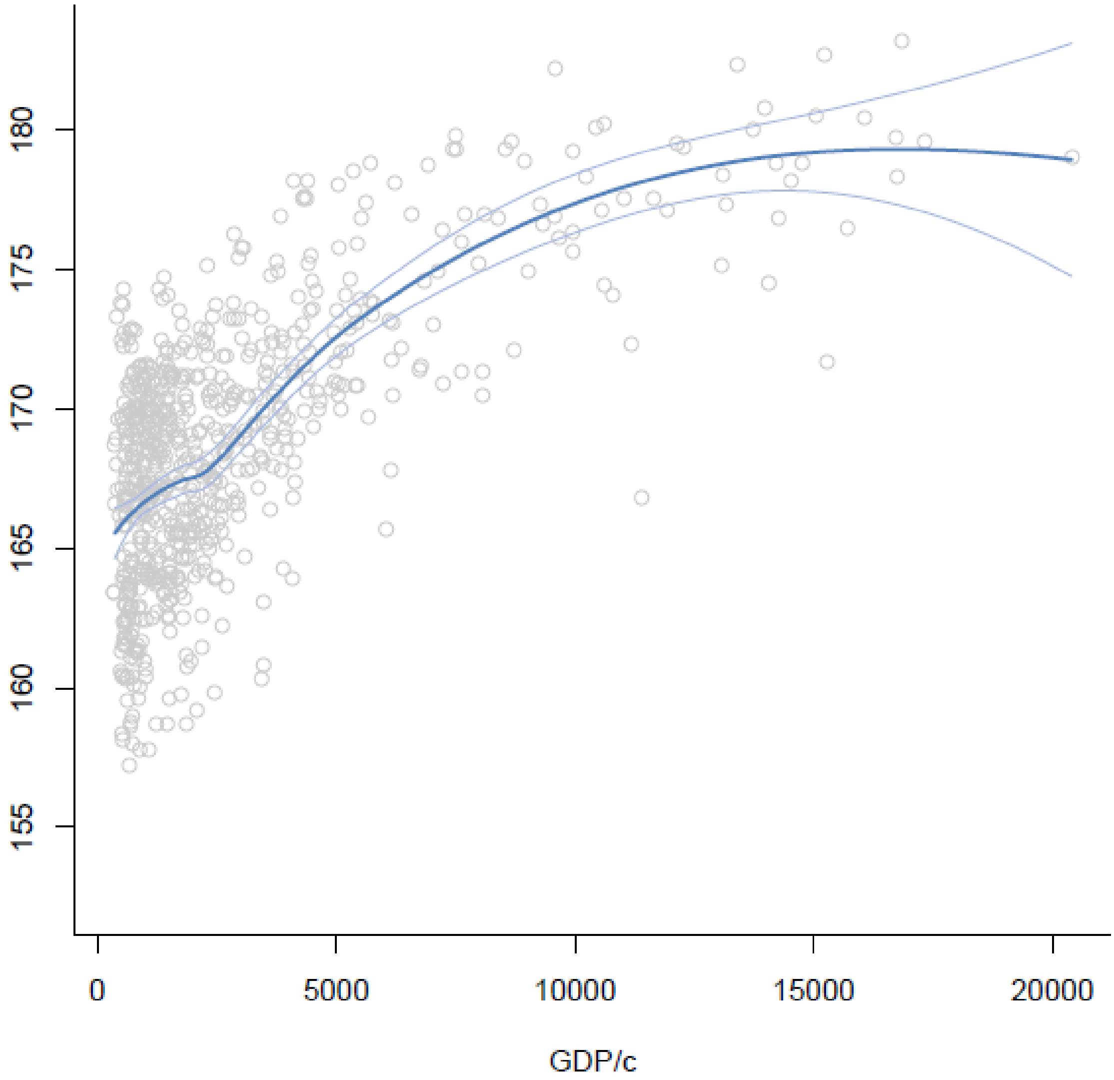
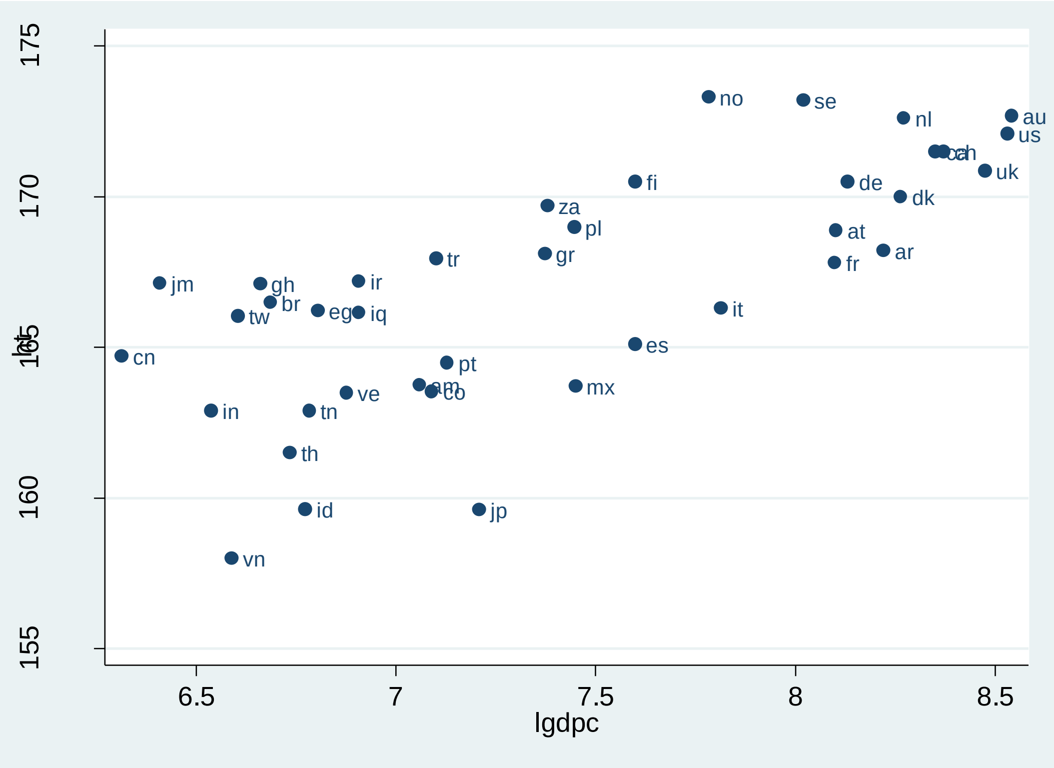


Figure 3: Height and GDP per capita (in logs), 1910s and 1980s

1910s



1980s

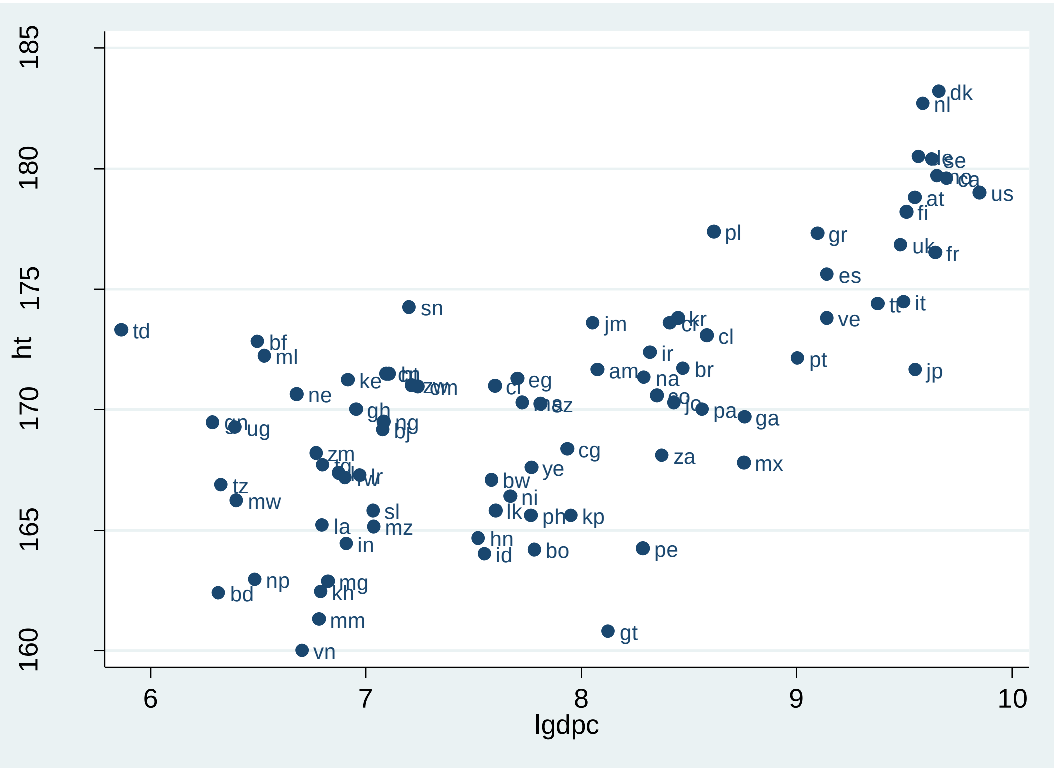


Figure 4: Correlations of Height and GDP per capita, file: \a\ci\hgtcor.pdf

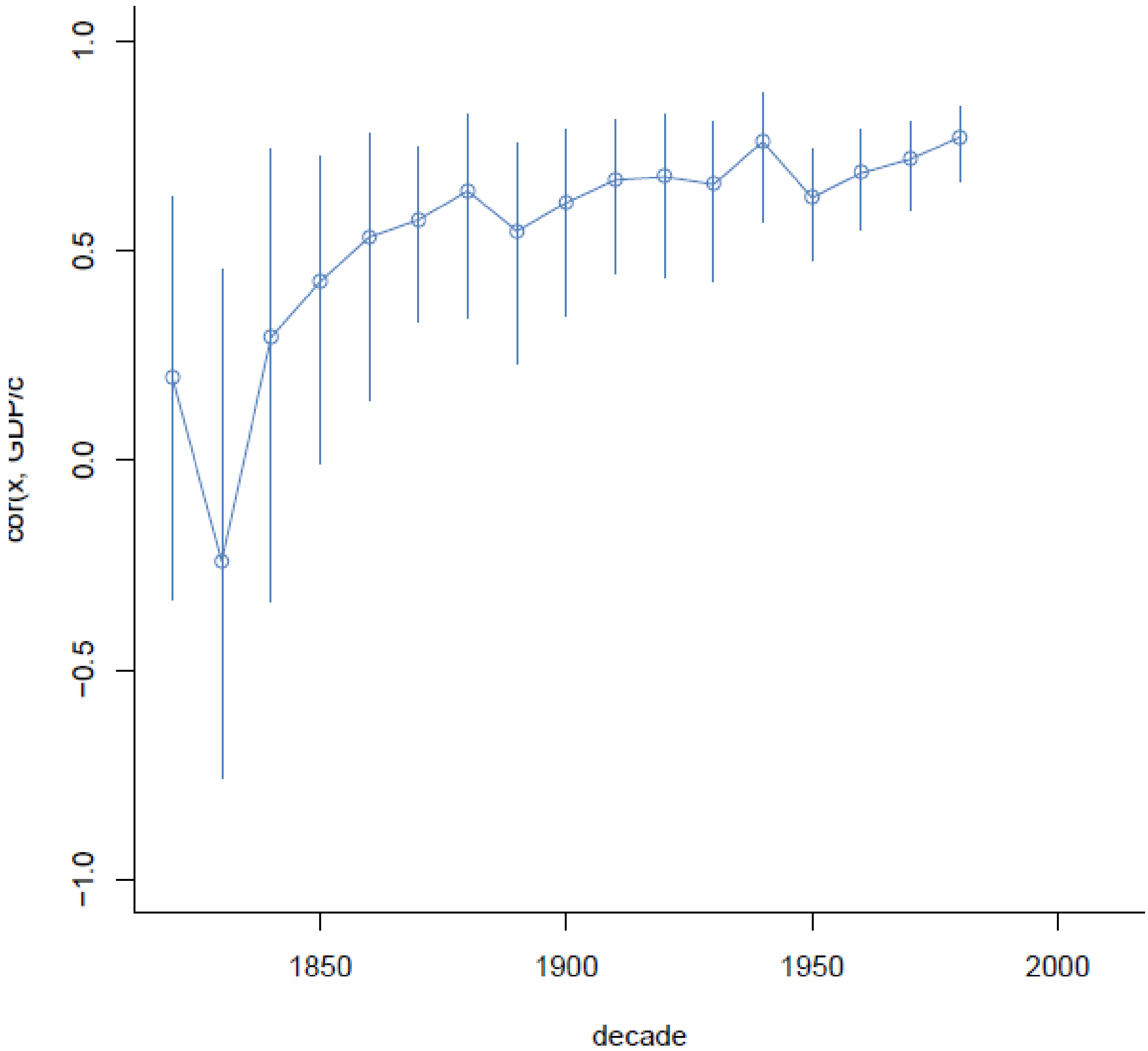
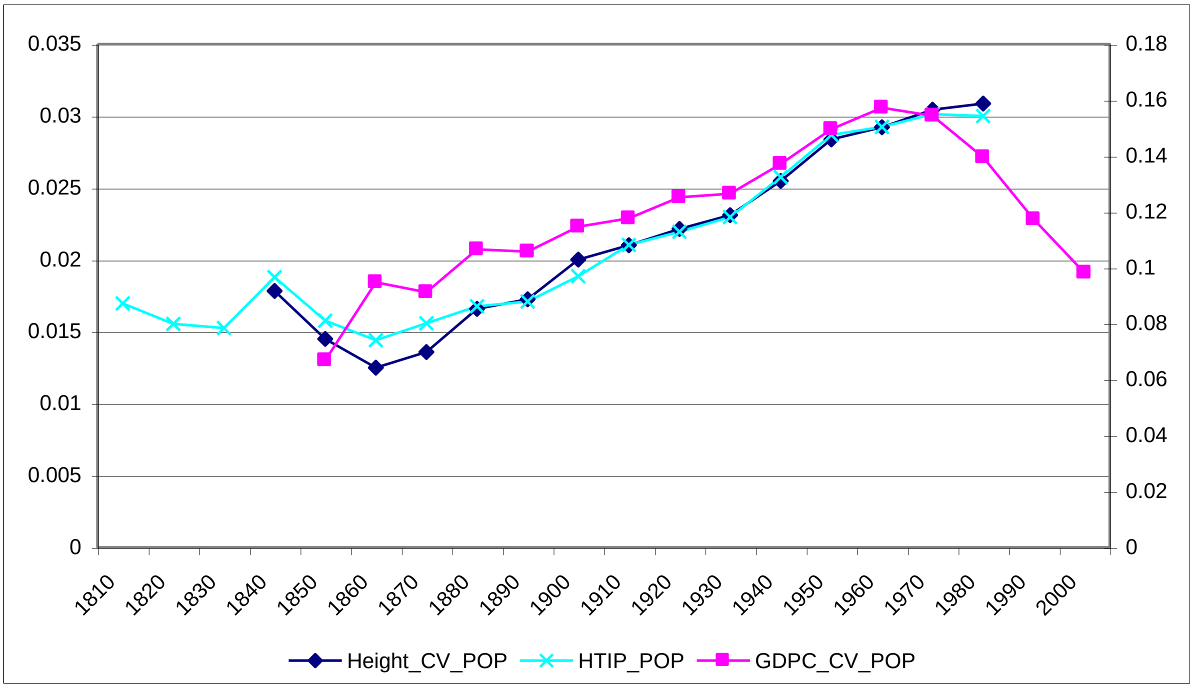


Figure 5: The coefficient of variation of height, height (incl. interpolation) and GDP



Note: All values weighted by population size. Height values are available between the 1840s and 1980s for 17 (1840s), 19, 21, 22, 23, 22, 23 (1900s), 25, 24, 22, 22, 23 (1950s), 23, 20, 19 (1980s). Interpolated height values are available: 22 for the 1810s-1850s, and 25 for 1860s-1980s. GDP values are available between the 1850s and 2000s for 18 (1850s), 16, 21, 16, 20, 19 (1900s), 21, 20, 20, 17, 23 (1950s), 23, 24, 23, 24, 24(2000s). . by bdec: pwcorr ht lgdp, sig

Appendix (file \a\ci\ght25.csv here only 3 countries shown)

Appendix Table A1: Decennial averages of stature in 25 Clio-Infra countries, 1820-1990.

dec	GBR	NLD	FRA
1820	169.1	165.1	163.9
1830	166.7	164.2	164
1840	166.5	164.5	164.3
1850	165.6	165.3	165.2
1860	166.6	166.5	165.4
1870	167.2	167.1	165.5
1880	167.9	168.5	165.9
1890	167.4	169.4	166.1
1900	169.4	170.9	166.8
1910	170.9	172.6	167.8
1920	171	173.5	168.5
1930	173.9	174.1	169.9
1940	174.9	177.5	171.7
1950	176	178.7	173.2
1960	176.9	182.2	174.9
1970	177.1	182.3	175.1
1980	176.8	182.7	176.5

Sources: see text