2

Why the Twentieth Century Was So Remarkable

Research during the past two decades has produced significant advances in the description and explanation of the secular decline in mortality. Although many of these findings are still tentative, they suggest a new theory of evolution that Dora Costa (an economist and biodemographer at MIT) and I call "techno-physio evolution." Studies of the causes of the reduction in mortality point to the existence of a synergism between technological and physiological improvements that has produced a form of human evolution that is biological but not genetic, rapid, culturally transmitted, and not necessarily stable.[1] This process is still ongoing in both rich and developing countries. In the course of elaborating this theory, thermodynamic and physiological aspects of economic growth will be defined, and their impact on economic growth rates will be discussed.

Unlike the genetic theory of evolution through natural selection, which applies to the whole history of life on earth, techno-physio evolution applies only to the past 300 years of *human* history and particularly to the past century.[2] Despite its limited scope, technophysio evolution appears to be relevant to forecasting likely trends over the next century or so in longevity, the age of onset of chronic diseases, body size, and the efficiency and durability of vital organ systems. It also has a bearing on such pressing issues of public policy as the growth in population, in pension costs, and in health care costs.

The theory of technophysio evolution rests on the proposition that during the past 300 years, particularly during the past century, human beings have gained an unprecedented degree of control over their environment – a degree of control so great that it sets them apart not only from all other species, but also from all previous generations of *Homo sapiens*. This new degree of control has enabled *Homo sapiens* to increase its average body size by over 50 percent and its average longevity by more than 100 percent since 1800, and to greatly improve the robustness and capacity of vital organ systems.

Figure 2.1 helps to point up how dramatic the change in the control of the environment after 1700 has been. During its first 200,000 or so years, *Homo sapiens* increased at an exceedingly slow rate. The discovery of agriculture about 11,000 years ago broke the tight constraint on the food supply imposed by a hunting and gathering technology, making it possible to release between 10 and 20 percent of the labor force from the direct production of food and also giving rise to the first cities. The new technology of food production was so superior to the old one that it was possible to support a much higher rate of population increase than had existed prior to c. 9000 B.C. Yet, as Figure 2.1 shows, the advances in the technology of food production after the *second* Agricultural Revolution (which began about A.D. 1700) were far more dramatic than the earlier breakthrough, since they permitted the population to increase at so high a rate that the line of population appears to explode, rising almost vertically. The new technological breakthroughs in manufacturing, transportation, trade, communications, energy production, leisure-time services, and medical services were in many respects even more striking than those in

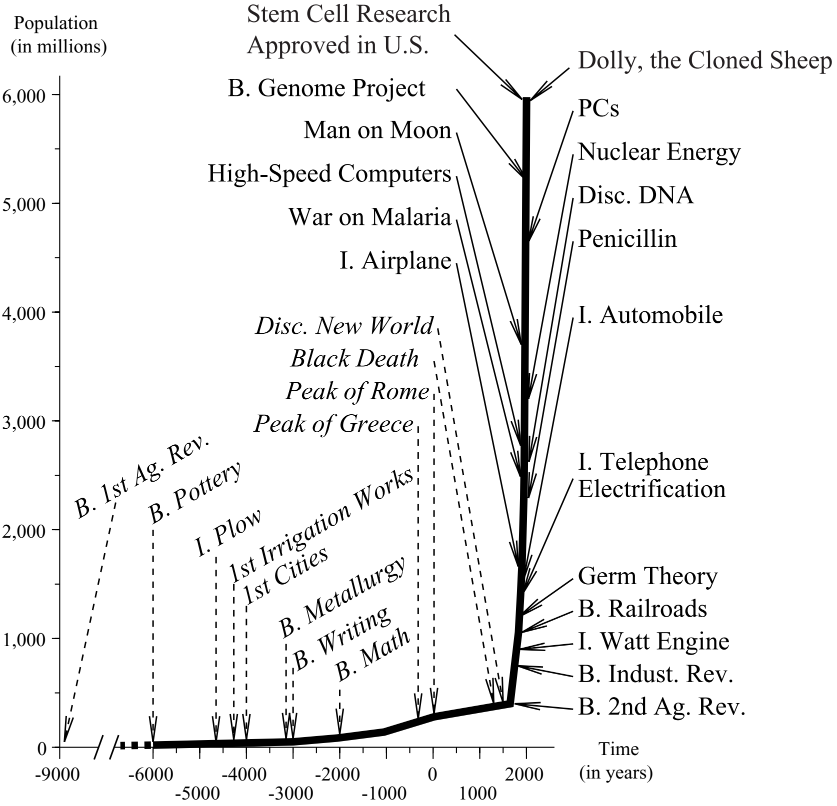

Figure 2.1 The Growth of World Population and Some Major Events in the History of Technology.

Sources: Cipolla 1974; Clark 1961; Fagan 1977; McNeill 1971; Piggott 1965; Derry and Williams 1960; Trewartha 1969. See also Allen 1992, 1994; Slicher van Bath 1963; Wrigley 1987.

Note: There is usually a lag between the invention (I) of a process or a machine and its general application to production. "Beginning" (B) usually means the earliest stage of this diffusion process.

agriculture. Figure 2.1 emphasizes the huge acceleration in both population and technological change during the twentieth century. The increase in the world's population between 1900 and 1990 was four times as great as the increase during the whole previous history of humankind.

The Relationship between Body Size and the Risk of Death at Middle and Late Ages

Although Figure 2.1 points to changes in technology that permitted a vast increase in population, it does not reveal a connection between technological changes and physiological benefits. To get at that question, we need to consider a number of recent studies that have demonstrated the predictive power of height and body mass with respect to morbidity and mortality at later ages. The results of two of these studies are summarized in Figures 2.2 and 2.3. Figure 2.2 plots the relationship between relative mortality risk and height found by Hans Waaler among Norwegian men aged 40–59 measured in the 1960s and among Union Army veterans measured at ages 23–49 and at risk between ages 55 and 75.[3] Short men, whether modern Norwegians or nineteenth-century Americans, were much more likely to die than tall men. Height

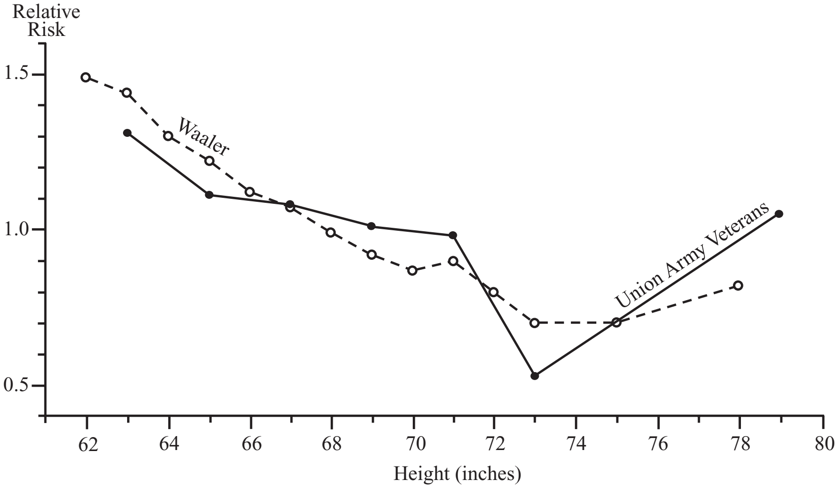

Figure 2.2 Relative Mortality Risk among Union Army Veterans and among Modern Norwegian Males.

Note: A relative risk of 1.0 means that the risk at that height was equal to the average risk of death in the entire population of males of the specified ages. Also note that the tallest data point, in both the Norwegian and Union Army cases, is not statistically significant.

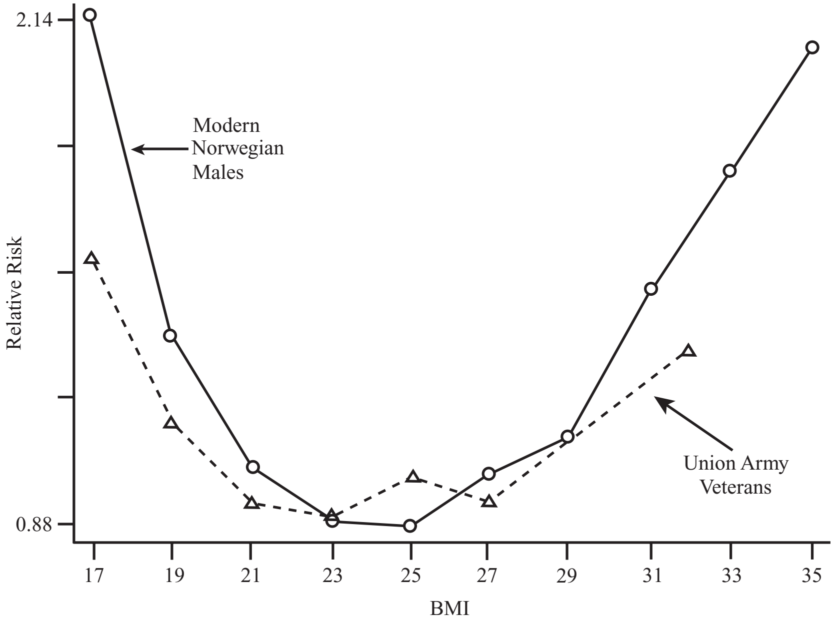

Figure 2.3 Comparison of Relative Mortality Risk by BMI among Men 50 Years of Age, Union Army Veterans around 1900 and Modern Norwegians.

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Note: In the Norwegian data, BMI for 79,084 men was measured at ages 45–49, and the period of risk was 7 years. BMI of 550 Union Army veterans was measured at ages 45–64, and the observation period was 25 years.

has also been found to be an important predictor of the relative likelihood that men aged 23–49 would have been rejected by the Union Army during 1861–65 because of chronic diseases.[4] Despite significant differences in ethnicity, environmental circumstances, the array and severity of diseases, and time, the functional relationship between height and relative risk is strikingly similar in the two cases.[5]

Waaler has also studied the relationship in Norway between body mass, measured by BMI, and the risk of death.[6] A curve summarizing his findings for men aged 45–49 is shown in Figure 2.3.

The curve for Union Army veterans measured at ages 45–64 and followed for 25 years is also shown in Figure 2.3. Among both modern Norwegians and Union Army veterans, the curve is relatively flat within the range 22–28, with the relative risk of mortality hovering close to 1.0. However, at BMIs of less than 22 and over 28, the risk of death rises quite sharply as BMI moves away from its mean value.

It is important to understand that, as used in this discussion, "risk" or "risk of death" refers to the likelihood of dying during any defined period of time; the risk period in Figure 2.4, for example, is 18 years. Mortality risk is most commonly presented as the crude death rate (CDR). In this diagram, a relative risk of 1.0 is the average risk of dying in the population as a whole over all heights and weights (i.e., the average crude death rate – the total deaths during a year divided by the midyear population). Greater or lower risks that vary with height and weight are all expressed relative to the average risk in the population as a whole. For example, a relative risk of 2.0 means having a risk that is twice the average CDR.

Although Figures 2.2 and 2.3 are revealing, they are not sufficient to shed light on the debate over whether moderate stunting impairs health when weight-for-height is adequate. To get at the "small-but-healthy" issue, one needs an iso-mortality surface that relates the risk of death to height and weight simultaneously. Such a surface is presented as a three-dimensional diagram in the frontispiece. For some purposes, it is more convenient to represent a three-dimensional surface in two dimensions, as is done in topographical maps. Such a two-dimensional surface, presented in Figure 2.4, was fitted to Waaler's data. Figure 2.4 combines three different types of curves. The solid curves are iso-mortality risk curves, each of which traces out all the combinations of height and weight that represent a given level of risk. Transecting the iso-mortality map is a set of iso-BMI curves, represented by dashed lines. Each iso-BMI curve is the locus of all of the combinations of height and weight that yield a specific level of BMI, ranging from

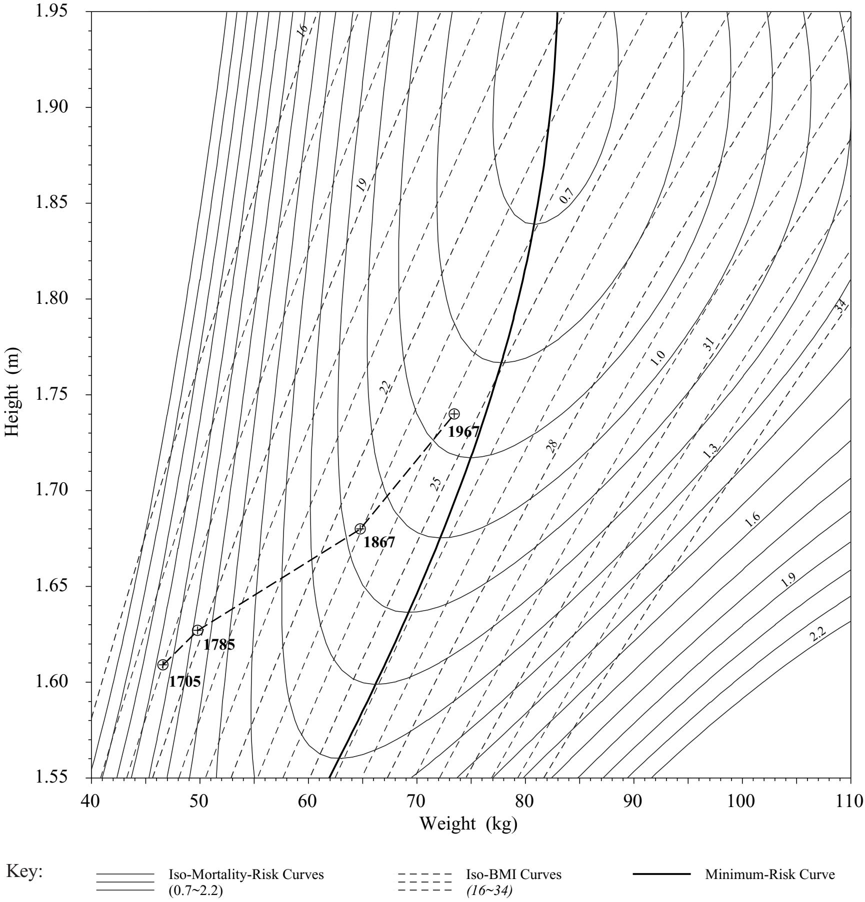

Figure 2.4 Iso-Mortality Curves of Relative Risk for Height and Weight among Norwegian Males Aged 50–64, with a Plot of the Estimated French Height and Weight at Four Dates.

Sources: Data points for 1705 and 1785 are from Fogel, Floud, and Harris, n.d.; the point for 1867 is from Baxter 1875, 1: 58–59; the point for 1967 is from Eveleth and Tanner 1976.

Note: For a brief description of the procedure used to estimate the 1705 and 1785 points, see Fogel 1997; a more extensive explanation appears in Fogel, Floud, and Harris, n.d. This figure supersedes versions that have appeared previously.

16 to 34. The heavy black curve running through the minimum point of each iso-mortality curve gives the weight that minimizes risk at each height.

Figure 2.4 shows that even when body weight is maintained at what Figure 2.3 indicates is an "ideal" level (BMI = 25), short men are at substantially greater risk of death than tall men. Figure 2.4 also shows that the ideal BMI varies with height. A BMI of 25 is ideal for men in the neighborhood of 176 cm (69 inches), but for tall men the ideal BMI is between 22 and 24, while for short men (under 168 cm or 66 inches) the ideal BMI is about 26.[7]

Superimposed on Figure 2.4 are rough estimates of heights and weights in France at four dates. In 1705 the French probably achieved equilibrium with their food supply at an average height of about 161 cm (63 inches) and a BMI of about 18. Over the next 290 years the food supply expanded with sufficient rapidity to permit both the height and the weight of adult males to increase. Figure 2.4 implies that while factors associated with height and weight jointly explain virtually all of the estimated decline in French mortality rates over the period between c. 1785 and c. 1867, they explain only about 35 percent of the decline in mortality rates between c. 1867 and c. 1967.[8]

The analysis in this section points to the misleading nature of the concept of subsistence as Malthus originally used it and as it is still widely used today. Subsistence is not located at the edge of a nutritional cliff, beyond which lies demographic disaster. Rather than one level of subsistence, there are numerous levels at which a population and a food supply can be in equilibrium in the sense that they can be indefinitely sustained. However, some levels will have smaller people and higher normal mortality than others.[9]

The Relevance of Waaler Surfaces for Predicting Trends in Chronic Diseases

Poor body builds increased vulnerability to diseases, not just contagious diseases but chronic diseases as well. This point is

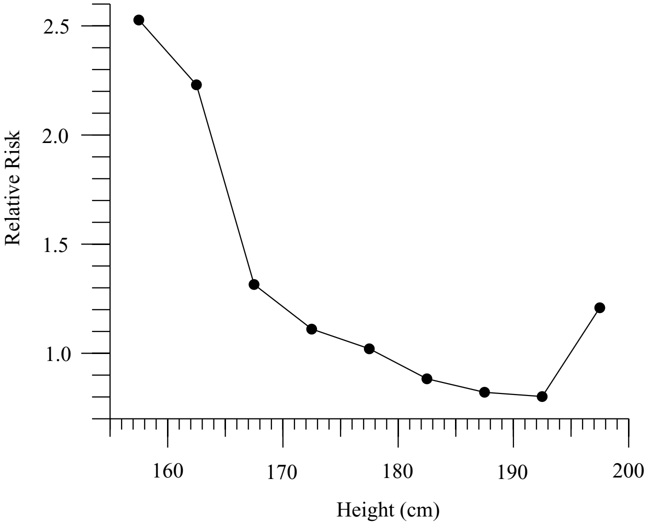

Figure 2.5 Relationship between Height and Relative Risk of Ill Health in NHIS Veterans Aged 40–59.

Source: Fogel, Costa, and Kim 1993.

Note: This curve is similar to the curve in Figure 2.2, except that Figure 2.5 gives the average risk of reporting poor health by height, whereas Figure 2.2 gives the average risk of dying by height. Also note that the tallest data point is not statistically significant.

demonstrated by Figure 2.5, which shows that chronic conditions were much more frequent among short young men than among tall men in the U.S. National Health Interview Surveys (NHIS) for 1985–88. Virtually the same functional relationship between stature and chronic diseases was found in the 1860s among young adult and middle-aged men examined by the surgeons of the Union Army. Stunting during developmental ages had a long reach and increased the likelihood that people would suffer from chronic diseases at middle and late ages.[10]

American males born during the second quarter of the nineteenth century were not only stunted by today's standards, but their BMIs at adult ages were about 10 percent lower than current U.S. levels (see Figure 2.6).[11] The difference in average BMI between adult males today and those born in the nineteenth century widened with age, perhaps because of the accumulated effects of

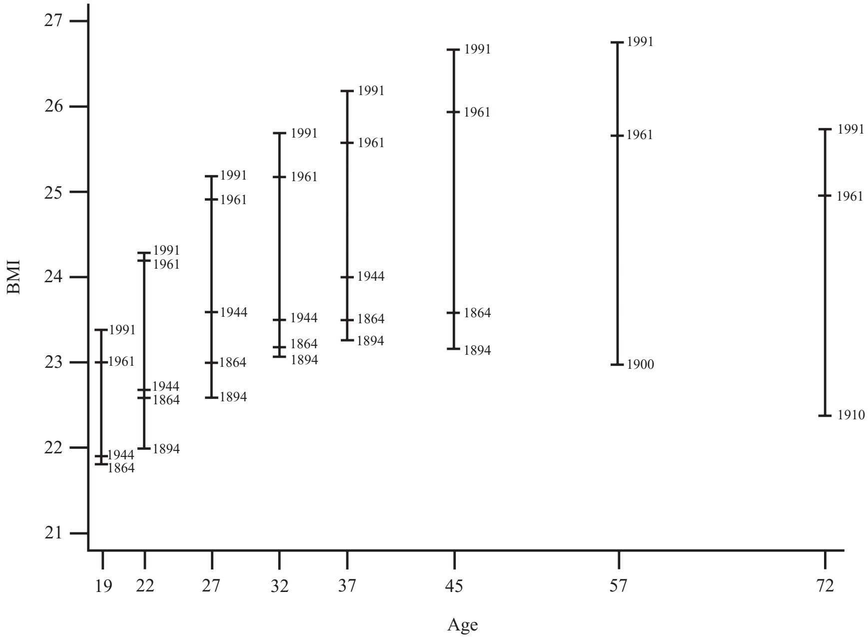

Figure 2.6 Mean BMI by Age Group and Year, 1864–1991.

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Note: The age groups are centered at the marks and are ages 18–19, 20–24, 25–29, 30–34, 35–39, 40–49, 50–64, and 65–79. For some years BMI is not available for a specific age group.

differences in nutritional intake and physical activity and because of the increased prevalence of chronic conditions at older ages (see Figure 2.6). The implication of combined stunting and low BMI is brought out in Figure 2.7, which presents a Waaler surface for morbidity estimated by John Kim (1993) from NHIS data for 1985–88 that is similar to the Norwegian surface for mortality (see Figure 2.4).

Figure 2.7 also presents the coordinates in height and BMI of Union Army veterans who were 65 or over in 1910 and of veterans (mainly of World War II) who were the same ages during 1985–88. These coordinates imply that increases in height and BMI should have led to a decline of about 35 percent in the prevalence of chronic diseases between the two cohorts.[12]

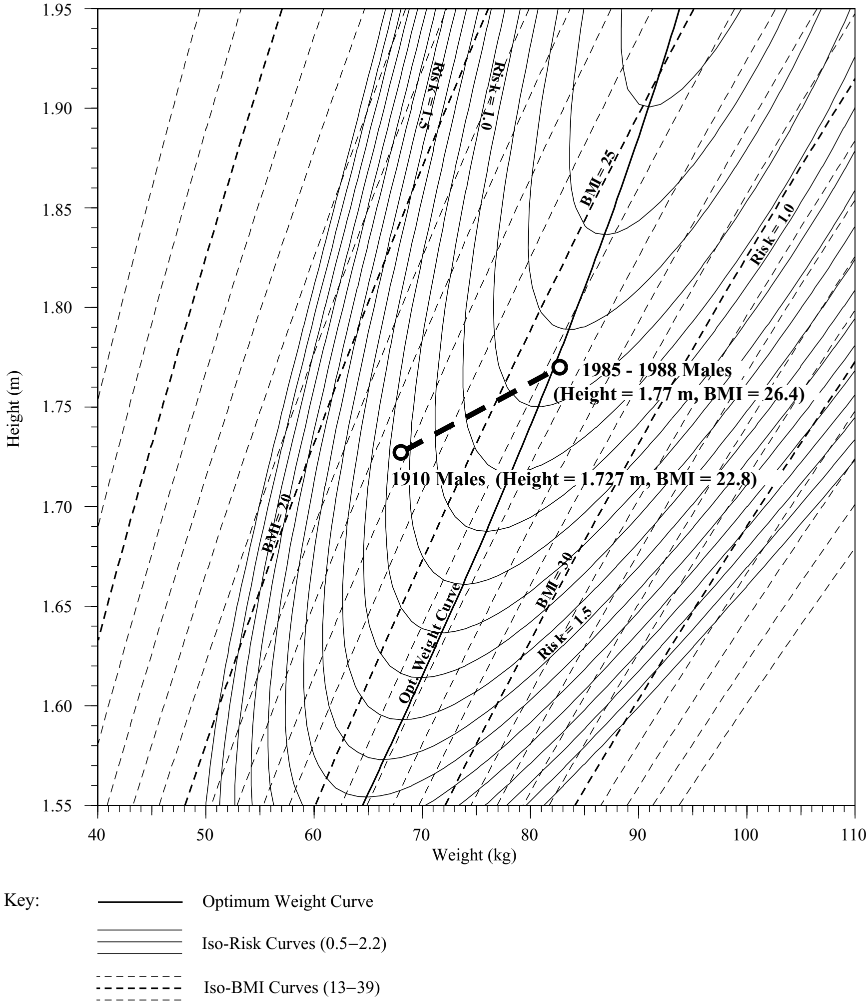

Figure 2.7 Health Improvement Predicted by NHIS 1985–88 Health Surface.

Source: Kim 1993.

Note: All risks are measured relative to the average risk of morbidity (calculated over all heights and weights) among NHIS 1985–1988 white males aged 45–64.

Table 2.1 Comparison of the Prevalence of Chronic Conditions among Union Army Veterans in 1910, Veterans in 1983 (Reporting Whether They Ever Had Specific Chronic Conditions), and Veterans in NHIS, 1985–88 (Reporting Whether They Had Specific Chronic Conditions during the Preceding 12 Months), Aged 65 and Above, Percentages

Disorder	*1910 Union Army Veterans*	*1983 Veterans*	*Age-Adjusted 1983 Veterans*	*NHIS 1985–88 Veterans*
Musculoskeletal	67.7	47.9	47.2	42.5
Digestive	84.0	49.0	48.9	18.0
Hernia	34.5	27.3	26.7	6.6
Diarrhea	31.9	3.7	4.2	1.4
Genitourinary	27.3	36.3	32.3	8.9
Central nervous, endocrine, metabolic, or blood	24.2	29.9	29.1	12.6
Circulatory[a]	90.1	42.9	39.9	40.0
Heart	76.0	38.5	39.9	26.6
Varicose veins	38.5	8.7	8.3	5.3
Hemorrhoids[b]	44.4			7.2
Respiratory	42.2	29.8	28.1	26.5

Notes: Prevailing rate of Union Army veterans are based on examinations by physicians. Those for the 1980s are based on self-reporting. Comparison of the NHIS rates with those obtained from physicians' examinations in NHANES II indicates that the use of self-reported health conditions does not introduce a significant bias into the comparison. See Fogel, Costa, and Kim 1993 for a more detailed discussion of possible biases and their magnitudes.

[a] Among veterans in 1983, the prevalence of all types of circulatory diseases will be underestimated because of underreporting of hemorrhoids.

[b] The variable indicating whether the 1983 veterans ever had hemorrhoids is unreliable.

Source: Fogel, Costa, and Kim 1993.

This exercise is consistent with what actually occurred.[13] Table 2.1 compares the prevalence of chronic diseases among Union Army men aged 65 and over in 1910 with two surveys of veterans of the same ages in the 1980s.[14] That table indicates that musculoskeletal and respiratory diseases were 1.6 times as prevalent, heart disease was 2.9 times as prevalent, and digestive diseases were 4.7 times as prevalent among veterans aged 65 or over in 1910 as in 1985–88. Young adults born between 1822 and 1845 who survived the deadly infectious diseases of childhood and adolescence were not freer of degenerative diseases than persons of the same ages today, as some have suggested, but were more afflicted. Hernia rates at ages 35–39, for example, were more than three times as high in the 1860s as in the 1980s. Of special note is the much higher incidence of clubfoot in the 1860s – a birth anomaly that suggests that the uterus was far less safe for those awaiting birth than it is today. The provisional findings thus suggest that chronic conditions were far more prevalent throughout the life cycle for those who reached age 65 before World War I than is suggested by the theory of the epidemiological transition.[15] Reliance on cause-of-death information to characterize the epidemiology of the past has led to a significant misrepresentation of the distribution of health conditions among the living. It has also promoted the view that the epidemiology of chronic diseases is more separate from that of contagious diseases than now appears to be the case.

What is the basis for the predictive capacity of Waaler surfaces and curves? Part of the answer resides in the realm of human physiology. Variations in height and weight appear to be associated with variations in the chemical composition of the tissues that make up these organs, in the quality of the electrical transmission across membranes, and in the functioning of the endocrine system and other vital systems.

Research in this area is developing rapidly, and some of the new findings have yet to be confirmed. The exact mechanisms by which malnutrition and trauma *in utero* or in early childhood are transformed into organ dysfunctions are still unclear. What is agreed upon is that the basic structure of most organs is laid down early, and it is reasonable to infer that poorly developed organs may break down earlier than well-developed ones.[16] The principal evidence so far is statistical and, despite agreement on certain specific dysfunctions, there is no generally accepted theory of cellular aging. Much of this evidence is described in Chapter 3.

Thermodynamic and Physiological Factors in Economic Growth

So far, I have focused on the contribution of technological change to physiological improvements. However, the process has been synergistic, with improvements in nutrition and physiology contributing significantly to the process of economic growth and technological progress.

I alluded to the thermodynamic contribution to economic growth when I pointed out that individuals in the bottom 20 percent of the caloric distributions of France and England near the end of the eighteenth century lacked the energy for sustained work and were effectively excluded from the labor force. Moreover, even those who participated in the labor force had only relatively small amounts of energy for work.

Since the first law of thermodynamics applies as much to human engines as to mechanical ones, it is possible to use energy cost accounting to estimate the increase in energy available for work over the past two centuries. In the British case the thermodynamic factor explains 30 percent of the British growth rate since 1790.[17] The increase in the amount of energy available for work had two effects. It raised the labor force participation rate by bringing into the labor force the bottom 20 percent of consuming units of 1790 who had, on average, only enough energy for a few hours of slow walking. Moreover, for those in the labor force, the intensity of work per hour has increased because the number of calories available for work each day increased by about 50 percent.[18]

The physiological factor pertains to the efficiency with which the human engine converts energy input into work output. Changes in health, in the composition of diet, and in clothing and shelter can significantly affect the efficiency with which ingested energy is converted into work output. Reductions in the prevalence of infectious diseases increase the proportion of ingested energy available for work both because of savings in the energy required to mobilize the immune system and because the capacity of the gut to absorb nutrients is improved, especially as a consequence of a reduction in diarrheal diseases. Thermodynamic efficiency has also increased because of changes in the composition of the diet, including the shift from grains and other foods with high fiber content to sugar and meats. These dietary changes raised the proportion of ingested energy that can be metabolized (increased the average value of the "Atwater Factors," to use the language of nutritionists). Improvements in clothing and shelter have also increased thermodynamic efficiency by reducing the amount of energy lost through the radiation of body heat.[19]

Moreover, individuals who are stunted but otherwise healthy at maturity will be at an increased risk of incurring chronic diseases and of dying prematurely. In other words, when considered as work engines, they wear out more quickly and are less efficient at each age. The available data suggest that the average efficiency of the human engine in Britain increased by about 53 percent between 1790 and 1980. The combined effect of the increase in dietary energy available for work, and of the increased human efficiency in transforming dietary energy into work output, appears to account for about 50 percent of the British economic growth since 1790.[20]

Making Economic Sense of the Conflicts between Economic and Biomedical Measures of Inequality

As already noted, traditional economic measures of the standard of living, such as per capita income and indexes of real wages, sometimes conflict with biomedical measures such as stature, BMI, and life expectancy. What are we to make of a situation in which real wages were rising, as apparently occurred in England during the last three quarters of the nineteenth century, while working-class heights and BMI remained at relatively low levels, showing little increase over half a century? How should we characterize conditions of workers in the United States between 1820 and 1860 if real wages were generally constant or rising, sometimes quite rapidly, but heights and life expectancy were decreasing?[21] During an era in which 50 to 75 percent of the income of workers was spent on food, is it plausible that the overall standard of living of workers was improving if their nutritional status and life expectancy were declining? Although these questions are not yet resolved, they are now being vigorously investigated.[22] It may be fruitful to consider some of the new issues about the course of the standard of living and their implications for the measurement of inequality that are suggested by the anthropometric and demographic data.

If cholera and other diseases that afflicted the United States during the nineteenth century were acts of God, unrelated to the functioning of the economic system, they would pose no special problem for the resolution of the standard-of-living controversy. However, economic growth, the spread of disease, and the concomitant increase in morbidity and mortality rates were intricately intertwined. Not only was internal migration responsible for as much as 50 percent of the increase in measured per capita income during the antebellum era,[23] it was also a principal factor in the spread of cholera, typhoid, typhus, malaria, dysentery, and other major killer diseases of the era.[24] Increasing population density, another concomitant of economic growth, also increased the prevalence of various diseases, raising the level of malaria, enteric diseases, and diseases of the respiratory system.[25]

The increase in mortality between 1790 and 1860, therefore, indicates that a downward adjustment is necessary even if wage rates in high-disease localities fully reflected the extra wage compensation (which economists refer to as a "bribe") that workers demanded for the increased risks of living in these areas, since national income accounting procedures treat the bribe as an increase in national income when it is merely a cost of production. Different ways of correcting estimates of the unmeasured cost of mortality, and of adjusting the national income accounts accordingly, are discussed in the notes. They show that much of what appears to have been a rise in real wages between 1790 and 1860 is spurious, and that the apparent growth in average real wages over these years needs to be reduced by at least 40 percent.[26]

So far, I have stressed that measures of per capita income exaggerate economic growth because they fail to remove costs of production from the measure of real income. This point is akin to Simon Kuznets's correction of national income for wages paid to police because crime is not a benefit but a cost of urban production.[27] However, even when average real wages are appropriately adjusted, the bearing of this line of argument on the measurement of trends in inequality during the nineteenth century is obscure because we lack the detail needed to correct the variations of income among wage earners as well as between wage income and other types of income. The veil is lifted somewhat, however, if we switch from the conventional economic measures of inequality to the biomedical measures. Data on life expectancy in Great Britain reveal that although the life expectancy of the lower classes remained constant or declined in some localities during much of the nineteenth century, the life expectancy of the upper classes rose quite sharply. From the beginning of the Industrial Revolution to the end of the nineteenth century, the gap in life expectancy between the upper and lower classes increased by about 10 years. Similarly, the gap in stature between the upper and lower classes appears to have increased between the end of the Napoleonic wars and the beginning of the twentieth century.[28]

In other words, the biomedical data suggest that the disparity between the upper and lower classes increased during much if not most of the nineteenth century. This is a different finding than calculations based on income distributions, which suggest that during most of the nineteenth century the inequality of the English income distribution remained constant. After considering the discrepancies between the traditional economic measures and the biomedical measures, I lean toward the conclusion that for the nineteenth century the biomedical measures are more laden with economic information than the traditional economic measures, at least where assessing secular trends in inequality is concerned.[29]

A preference for biomedical measures over conventional economic measures of inequality seems even more warranted when interpreting trends in the twentieth century. In both the British and the U.S. cases, life expectancy increased dramatically between 1890 and 1930, by about 14 years in Britain (a 31 percent increase) and by about 16 years (a 36 percent increase) in the United States.[30] Over the same period, U.S. stature increased by about 6 cm. However, in both the British and American cases, measures such as the share of income held by the top 5 or 10 percent of the income distribution show that inequality was relatively constant over this period or that it might have increased slightly.[31] The experience of the Depression Decade is even more paradoxical. In the United States the unemployment rate between 1931 and 1939 varied but was never less than 16 percent; for half of the period, unemployment ranged between 20 and 25 percent. Yet life expectancy between 1929 and 1939 increased by 4 years and the heights of men reaching maturity during this period increased by 1.6 cm.[32]

The resolution of the paradox turns on the huge social investments made between 1870 and the end of World War I, whose payoffs were not counted as part of national income during the 1920s and 1930s even though they produced a large stream of benefits during these decades and continue to do so down to the present. I refer, of course, to the social investment in public health and in biomedical technology, whose largest payoffs came well after the investment was made. Included in this category are not only the direct federal investments in biomedical research, which remained modest before 1950, but also the expansion of clinical medicine practiced in a vastly expanded network of hospitals established on scientific principles, the quadrupling of higher education in medicine and the increase in the quality of that education, and the international expansion of the stock of knowledge of the biology, chemistry, and epidemiology of disease. Also included in this category are such public health investments as the construction of facilities to improve the supply of water, the purification of the milk supply, the development of effective systems of quarantines, and the cleaning of the slums.

The point is not merely that these benefits are often excluded entirely from national income accounts, and from the measures of real wages, but that they are greatly undervalued even when some aspects are included, because they are measured by inputs rather than by benefits (which are outputs). Moreover, these benefits accrued disproportionately to those with modest incomes. That those who occupy the lower rungs of society have gained more from certain forms of unmeasured income is visible in the biomedical measures because they show by how much the gap in life expectancy, in stature, and in BMI that once existed between the upper and lower income classes has been reduced.[33]

The discussion of omitted variables so far indicates that much less progress was made by the lower classes during the nineteenth century than is shown by conventional measures and that, as some have argued, the relative condition of the working class may have deteriorated during major parts of the century. The implication for the twentieth century is the reverse: omitted variables lead to an underestimate of the absolute and relative gains of the lower classes. Would these conclusions still hold if another omitted variable, leisure, was brought into consideration?

Although there were some gains in leisure for the lower class in the United States and Britain during the nineteenth century, they do not appear to have occurred until well past the middle of the century. Of the roughly 25-hour reduction in the work week between 1860 and 1990, perhaps 5 or 6 hours were eliminated before 1890. Moreover, the scope of leisure-time activities was narrow, limited primarily to frequenting bars and attending church. Drama, opera, ballet, concerts, literature, and visual arts were usually too expensive to be readily accessible to the poor. Although there were antecedents during the nineteenth century, public libraries, movies, radio, television, and the like are mainly products of the twentieth century.[34]

Kuznets, who was the leading designer of the U.S. national income accounts, recognized the large underestimate of economic growth occasioned by the omission of leisure from these accounts. Valuing the increased daily hours of leisure of workers at the average wage, he pointed out, would raise per capita income in the late 1940s by about 40 percent. Today, the figure would be closer to 120 percent. If such a computation was undertaken for each decile of the income distribution, it would be apparent that those in the top decile experienced much less of a gain in leisure, since the highly paid professionals and businessmen who populate the top decile work closer to the nineteenth-century standard of 3,200 hours per year than to the current middle-income standard of about 1,800 hours. Improvements in the variety and quality of leisure-time activities have also been less for the upper than the lower classes. The upper classes still have a proclivity for those expensive amusements that are most fully measured – opera, concerts, drama, literature. That proclivity, combined with their longer work week, means that they spend far less of their time in those forms of leisure activity for which the unmeasured gains have been greatest.[35]

The Remarkable Reduction in Inequality during the Twentieth Century

The twentieth century contrasts sharply with the record of the two preceding centuries. In every measure that we have bearing on the standard of living, such as real income, homelessness, life expectancy, and height, the gains of the lower classes have been far greater than those experienced by the population as a whole, whose overall standard of living has also improved.

The "Gini ratio," which is also called the "concentration ratio," is the measure of the inequality of the income distribution most widely used by economists.[36] This measure varies between 0 (perfect equality) and 1 (maximum inequality). In the case of England, for example, which has the longest series of income distributions, the Gini ratio stood at about 0.65 near the beginning of the eighteenth century, at about 0.55 near the beginning of the twentieth century, and at 0.32 in 1973, when it bottomed out, not only in Britain but also in the United States and other rich nations.[37] This measure indicates that over two-thirds of the reduction in the inequality of income distributions between 1700 and 1973 took place during the twentieth century. The large decrease in such inequality, coupled with the rapid increase in the average real income of the English population, means that the per capita income of the lower classes was rising much more rapidly than those of the middle or upper classes.[38]

A similar conclusion is implied by the data on life expectancies. For the cohort born about 1875, there was a gap of 17 years between the average length of life of the British elite and of the population as a whole. There is still a social gap in life expectancies among the British, but today the advantage of the richest classes over the rest of the population is only about 4 years. Thus about three-quarters of the social gap in longevity has disappeared. As a consequence, the life expectancy of the lower classes increased from 41 years at birth in 1875 to about 74 years today, while the life expectancy of the elite increased from 58 years at birth to about 78 years. That is a remarkable improvement. Indeed, there was more than twice as much increase in life expectancies during the past century as there was during the previous 200,000 years. If anything sets the twentieth century apart from the past, it is this huge increase in the longevity of the lower classes.[39]

Data on stature also indicate the high degree of inequality during the nineteenth century. At the close of the Napoleonic wars, a typical British male worker at maturity was about 5 inches shorter than a mature male of upper-class birth. There is still a gap in stature between the workers and the elite of Britain, but now the gap is only on the order of 1 inch. Height differentials by social class have virtually disappeared in Sweden and Norway but not yet in the United States. Statistical analysis across a wide array of rich and poor countries today shows a strong correlation between stature and the Gini ratio.[40]

Weight is another important measure of inequality. Despite the great emphasis in recent years on weight reduction, the world still suffers more from undernutrition and underweight than from overweight, as the World Health Organization has repeatedly pointed out. Although one should not minimize the afflictions caused by overnutrition, it is important to recognize that even in rich countries such as the United States, undernutrition remains a significant problem, especially among impoverished pregnant women, children, and the aged.

The secular increase in body builds is due primarily to the great improvement in socioeconomic conditions over the past several centuries, rather than to genetic factors, as can be seen by considering Holland. The average height of young adult males was only 64 inches in that country during the middle of the nineteenth century. The corresponding figure today is about 72 inches. An increase of 8 inches in just four generations cannot be due to natural selection or genetic drift because such processes require much longer time spans. Nor can it be attributed to heterosis (hybrid vigor) because Holland's population has remained relatively homogeneous and because the effects of heterosis in human populations have been shown both empirically and theoretically to have been quite small. It is hard to come up with credible explanations for the rapid increase in heights that do not turn on environmental factors, especially improvements in nutrition and health. These environmental factors appear to be still at work. Stature is still increasing, although at a somewhat slower rate, and nations have not yet reached a mean height that represents the biological limit of humankind under current biomedical technology.[41]

Homelessness is another indicator of the dramatic reduction in inequality during the twentieth century. Down to the middle of the nineteenth century, between 10 and 20 percent of the population in Britain and on the Continent were homeless persons whom officials classified as vagrants and paupers. Estimates of vagrancy and pauper rates in the United States during the nineteenth century are less certain, but these rates appear to have reached European levels in the major cities during the middle decades of that century. When we speak of homelessness in the United States today, we are talking about rates below 0.4 percent of the population. Many of the homeless today are mentally ill individuals prematurely released from psychiatric institutions that are inadequately funded. Many others are chronically poor and inadequately trained for the current job market.[42]

The relatively generous poverty program developed in Britain during the second half of the eighteenth century, and the bitter attacks on that program by Malthus and others, have given the unwarranted impression that government transfers played a major role in the secular decline in beggary and homelessness. Despite the relative generosity of English poor relief between 1750 and 1834, beggary and homelessness fluctuated between 10 and 20 percent. Despite the substantial reduction in the proportion of national income transferred to the poor as a result of the poor laws of 1834 and later years, homelessness declined sharply during the late nineteenth and early twentieth centuries.

The fact is that government transfers were incapable of solving the problems of beggary and homelessness during the eighteenth and much of the nineteenth centuries, because the root cause of the problems was chronic malnutrition. Even during the most generous phases of the relief program, the bottom fifth of the English population was so severely malnourished that it lacked the energy for adequate levels of work.[43]

At the end of the eighteenth century British agriculture, even when supplemented by imports, was simply not productive enough to provide more than 80 percent of the potential labor force with enough calories to sustain regular manual labor. It was the huge increases in English productivity during the later part of the nineteenth and the early twentieth centuries that made it possible to feed even the poor at relatively high caloric levels. Begging and homelessness were reduced to exceedingly low levels, by nineteenth-century standards, only when the bottom fifth of the population acquired enough calories to permit regular work. The principal way in which government policy contributed to that achievement was through its public health programs. By reducing exposure to disease, more of the calories that the poor ingested were made available for work.