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Foreword

One of the most useful additions to the tools for the examination of long-term historical change has been the increased use of anthropometric data. These include information on height, health, nutrition, and life expectation. The use of these measures has been important for a wide range of historical questions, largely, but not limited to, those in economic history and including demography, development economics, and medical and nutritional history. Several decades back, when the historical uses of height were first introduced, such measures were only infrequently used. Indeed, such measures were often treated with skepticism or even, at times, with derision. As with most innovations, the acceptance of this approach required detailed empirical analysis and theoretical tests before acceptance was widespread. The major accomplishments of anthropometric history have established it as a central tool of comparative studies, over space as well as time. Among the major contributors to this body of research has been Robert Fogel, whose seminal work in this area covers a period of over two decades. This volume includes some of Fogel's published and unpublished works, indicating the breadth and depth of his studies as well as suggesting directions for further research.

The diverse sources of anthropometric information include data on heights, most frequently drawn from military recruitment records, which exist for numerous countries after the eighteenth century; data on mortality, drawn from statistics of death by age; and data on food supplies, based on records of agricultural production from censuses

and other sources. However, some sources are unique to a particular time and place such as the mortality and health records resulting from the U.S. Civil War. This wide range of data permits the analysis of a broad spectrum of questions that can be of interest, particularly since they permit a very broad range of comparisons over time and geographical areas. Fogel's papers in this volume, some jointly authored but most singly authored, are an excellent example of the role anthropometric history has played in dealing with some new but also some traditional, historical problems.

These essays not only provide for a substantive understanding of the past but also illustrate the costs and benefits of using the measures, the difficulties of drawing interpretations from data prepared for quite different purposes, and the techniques that can be used to overcome the possible biases in the raw data. This broad sweep of concerns is seen particularly in Chapter 2, "Secular Changes in American and British Stature and Nutrition," which is the result of an early work in Fogel's broad project. The primary measure is of heights, used to measure changes in standards of living over time. On the basis of a variety of data sources for several different countries, including comparisons of American and British heights, and of American-born, Trinidadian-born, and African-born slaves, this analysis points to a number of interesting conclusions. These include the early achievement of modern levels of stature in the United States during and after the colonial period, the greater height of American adult males than those of England and elsewhere in Europe throughout the nineteenth century, and the greater height of U.S. slaves than those born in Trinidad and the even lower heights of those who were African born. These conclusions have proven robust in further studies, including one of the more unexpected of the results, that movements in heights did not always follow a linear trend but rather experienced cyclical fluctuations over time.

Chapter 3, "Second Thoughts on the European Escape from Hunger," studies British and French food consumption, heights, and mortality to provide several important historical points. The study of the time pattern of mortality, based primarily on the Wrigley–Schofield estimates, shows that the decline in British mortality was due mainly to improvements in overall consumption and real wages, with only a

relatively small part due to the dramatic effects of declines in famine and harvest failures. Studies based on food availability suggest that in earlier centuries, a relatively large part of the population was not provided with adequate nutrition to be highly productive. In addition to indicating one key reason for limited economic growth in this period, the need for and provision of government-provided poor relief are highlighted.

Chapter 4, "Trends in Physiological Capital," follows one of the themes of the previous chapter, using data on the improvements in European heights in the nineteenth century to argue for a change from chronic malnutrition and reduced labor input to the expansion of work inputs related to better nutrition for the bulk of the population. The term *physiological capital* is a supplement to the more familiar terms of *human capital* and *health capital* and is used to explain not only the impact of higher birth weights on infant mortality but also the delayed onset of some chronic diseases and the increase in longevity. These developments are often ignored in explanations of economic growth, but as Fogel clearly demonstrates, they have played a major role in the process.

Chapter 5 uses several data sources to examine the role of childhood diseases in the subsequent development of chronic diseases. Consistent with previous arguments, Fogel points out that there has been a significant decline in disease rates, with the onset of these declining rates particularly marked after 1700 and accelerating in the course of the twentieth century. Noteworthy also was the decline in the inequality of heights and mortality within and between nations in this period, an indication of the broad diffusion of the benefits of increased agricultural productivity and therefore nutrition. These findings provide an important supplement to discussions of changing standards of living based exclusively on wage and income data.

The basic findings of the anthropometric approach to historical analysis have, as Fogel describes in the interview concluding the volume, meant some important reinterpretations of the nature of economic growth. The human body and its capacity at laboring and surviving have changed dramatically in those nations experiencing economic growth, highlighting the importance of agricultural productivity and improved nutrition. Clearly the physical capabilities of those

in the developed nations in the twentieth century are quite different from those of their populations in the eighteenth and nineteenth centuries as well as from those in the less developed world today. Thus, as Fogel suggests, and his contributions demonstrate, new approaches and methods can lead to important new insights into historical changes.

– Stanley L. Engerman

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Secular Changes in American and British Stature and Nutrition

This chapter discusses the usefulness of data on height for the analysis of the impact of long-term changes in nutritional status and health on economic, social, and demographic behavior. In this chapter, measures of height are used for two related purposes. First, mean height at specific ages is used as a measure of the standard of living. When used in this way, data on height supplement other evidence such as indexes of real wages, estimates of per capita income, and measures of food consumption. One advantage of height data is their abundance and wide coverage of socioeconomic groups. Consequently, it is possible to develop continuous series for a wide range of geographical areas as well as for quite refined occupational categories. It is also possible to develop far more refined measures of the extent to which particular classes and areas were affected by changes in economic fortunes than has so far been possible through the use of either real wage indexes or measures of per capita income. Although it is unlikely that large bodies of height-by-age data will be uncovered for periods before 1700, the data are abundant from 1700 on, adding more than a century to most of the current series on per capita income. The wide geographical and occupational coverage offers the possibility that aggregate indexes constructed from them will be more representative of national trends

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than are long-term wage indexes, which are composed of narrow, discontinuous series.[1]

PRINCIPAL SAMPLES AND PROCEDURES

The chapter is based on a set of thirteen samples of data containing information on height-by-age and various socioeconomic variables that cover the period from 1750 through 1937 for the United States, Trinidad, Great Britain, and Sweden. Six of the samples are from U.S. military records for the period from 1750 to 1900. The other three U.S. samples contain information on both sexes: the sample of coastwise manifests provides information about slaves who boarded coastwise vessels between 1810 and 1863; the Fall River survey covers working children of school age during 1906–1907; and the cost of living survey covers all family members in a sample of households from 1934 to 1937. The Trinidad data set consists of complete censuses of the slaves on the island in 1813, with updates in 1814 and 1815, and then every three years until 1834.

One of the British samples is composed of poor boys from various parts of Great Britain, especially London, taken in by the Marine Society, a charitable organization, from 1750 to 1910; the other is

[1] Time series on height may be more reliable indicators of long-term changes in the welfare of the laboring classes than are the currently available indexes of real wages. Critics of the real wage indexes that have been computed for the eighteenth and nineteenth centuries, in both the United States and Great Britain, have noted the problems that beset the existing time series of nominal wages as well as the price deflators. The nominal wages for particular localities and particular occupations often remain relatively fixed over many years, sometimes even during periods of sharp fluctuations in the level of prices, so that the trend in real wages depends heavily on the choice of price indexes. Price deflators are generally lacking in information on the cost of shelter, which, in the more rapidly growing cities, may have accounted for more than one-quarter of the income of laborers. Efforts to turn wage indexes of particular occupations and localities into general regional or national wage indexes have produced nominal wage indexes, the movements of which are dominated for long periods of time by changes in a few occupations or localities and by discontinuities in underlying series. Von Tunzelmann's (1979) recent examination of the real wage series for England revealed that different reasonable ways of combining the individual series of nominal wage rates and the choice of different price deflators could imply either a rise of 250% in the national average of real wages between 1750 and 1850 or no rise at all. Data on height by occupation are more complete in their geographical scope than the wage data, especially for the lower-wage occupations, and do not need to be deflated by price indexes.

drawn from military recruitment records compiled between 1750 and 1910. The Swedish sample is drawn from muster rolls of army reserves who served from 1765 to 1885.

Measures of height are employed as the principal index of nutritional status. Both laboratory experiments on animal populations and observational studies of human populations have led physiologists and nutritionists to conclude that anthropometric measurements are reliable indexes of the extent of malnutrition among the socioeconomic classes of particular populations. Measures of height and weight at given ages, the age at which growth of stature terminates, attained final height, and especially the rate of change in height or weight during the growing ages "reflect accurately the state of a nation's public health and the average nutritional status of its citizens" (Eveleth and Tanner 1976, 1). Consequently, these measures are widely used by the World Health Organization and other agencies to assess the nutritional status of the populations of underdeveloped nations.[2]

The use of anthropometric measures as measures of nutrition rests on a well-defined pattern of human growth between childhood and maturity. The average annual increase in height (velocity) is greatest during infancy, falls sharply up to age three, and then falls more slowly throughout the remaining preadolescent years. During adolescence, velocity rises sharply to a peak that is approximately one-half of the velocity achieved during infancy, then falls sharply, and reaches zero at maturity. In girls, the adolescent growth spurt begins about two years earlier, and the magnitude of the spurt is slightly smaller than in boys. This growth pattern reflects the interaction of genetic, environmental, and socioeconomic factors during the period of growth. According to Eveleth and Tanner (1976, 176),

> such interaction may be complex. Two genotypes which produce the same adult height under optimal environmental circumstances may produce different heights under circumstances of privation. Thus two children who would be the same height in a well-off community may not only both be smaller

[2] Appendix A of Fogel et al. (1982) summarizes the findings of the principal studies. For more extensive descriptions, see Tanner (1981, 1990). The relationship between height per capita income and the distribution of income in modern populations is analyzed in Steckel (1983). For a summary of the evidence on the relationship between anthropometric measures, nutrition, and health, see Eveleth and Tanner (1976) and Frisancho (1978).

under poor economic conditions, but one may be significantly smaller than the other. . . . If a particular environmental stimulus is lacking at a time when it is essential for the child (times known as "sensitive periods"), then the child's development may be shunted, as it were, from one line to another.

The relative importance of environmental and genetic factors in explaining individual variations in height is still a matter of some debate. For most well-fed contemporary populations, however, systematic genetic influences appear to have a modest impact on mean heights. For example, the mean heights of well-fed Western Europeans, North American whites, and North American blacks are similar. There are some ethnic groups in which mean final heights of well-fed persons today differ significantly from the Western European or North American standards; in these cases, the deviation from the European standard appears to be due to genetic factors. However, because such ethnic groups have represented a miniscule proportion of American and European populations, they are irrelevant to an explanation of the observed secular trends in mean final heights in the United States and in the various European nations since 1750, nor can they account for differences at various points of time between the means in the final heights of the U.S. population and the principal populations from which the population was drawn. In this connection, it should be noted that today, the mean final heights of well-fed males in the main African nations from which the U.S. black population is derived also fall within the narrow band designated as the Western European standard.[3]

Physiologists, anthropologists, and nutritionists have charted the effect of nutritional deficiencies on the human growth profile. Short periods of severe malnutrition or prolonged periods of moderate malnutrition merely delay the adolescent growth spurt; severe, prolonged

[3] The belief that heterosis (hybrid vigor) would make Americans substantially taller than the ethnic groups from which they were drawn has not been sustained by previous anthropometric research. See Cavalli-Sforza and Bodmer (1971) for a theoretical argument as to why the effect of heterosis in human populations is small. Our investigations have failed to yield consistent signs on dummy variables for either males or females born of mixed unions. The magnitudes of the positive coefficients for adults, not all of which are statistically significant, fall in the range of 0.17–0.66 inches. The average of all the coefficients so far estimated for adults ($N = 9$) is 0.19 inches. Even this small difference is not necessarily due to heterosis; it might reflect differences in treatment during the growing years (Eveleth and Tanner 1976; Fogel et al. 1982).

malnutrition may diminish the typical growth spurt pattern and contribute to substantial permanent stunting. If malnutrition is both prolonged and moderate, growth will continue beyond the age at which the growth of well-fed adolescents ceases. Hence the average age at which the growth spurt peaks, the average age at which growth terminates, the mean height during adolescent ages, and the mean final height are all important indicators of mean nutritional status. Any one of these factors can be used to trace secular trends in nutrition. The more of these measures that are available, the more precise is the determination of the severity and duration of periods of malnutrition.

In considering the relationship between nutrition and height, it is important to stress that height is a net rather than a gross measure of nutrition. Moreover, although changes in height during the growing years are sensitive to current levels of nutrition, mean final heights reflect the accumulated past nutritional experience stretching not only over the growing years of the individuals measured but over the lifetimes of their mothers and perhaps of their grandmothers as well. Thus, when mean final heights are used to explain differences in productivity, they reveal the effect not of current levels of nutrition on productivity but of the net nutritional levels during the growing years of the measured individuals and, to an extent still to be established, of conditions during their mothers' and grandmothers' lives.

The measure of net nutrition represented by mean heights depends on the intake of nutrients, on the amount of nutrients available for physical growth after the necessary claims of work and other activities (including recovery from infections), and on the efficiency with which the body converts nutrients into outputs. The body's ability to generate a surplus for growth will vary with such factors as age; the climate; the nature of the available food, clothing, and shelter; the disease environment; the intensity of work; and the quality of public sanitation. The same nutritional input can have varying effects, depending on environmental conditions. The differing nutritional requirements for different intensities of work and other environmental conditions suggest that changes in the level of gross input (measured by food consumption) might not provide a full indication of changes in the nutrients available for physical growth. It is important to stress that although mean height measures the cumulative effect of the nutrients available after allowing for physical maintenance, work, and the impact of the man-made

and natural environment, it does not by itself indicate whether fluctuations in net nutrition are due to changes in the consumption of food, the claims on the food intake, or the efficiency with which food is converted into outputs.[4]

It cannot be assumed that there has been an invariable relationship, regardless of time and place, between height and such other important variables as occupation, wealth, literacy, ethnicity, residence, fertility, mortality, morbidity, migration, and a variety of intergenerational variables. Much attention has been devoted to determining which relationships are stable and which are not and to the determination of the factors that have been influential in shifting relationships.

Although the findings to date are illuminating, the process of mapping the relationship between height and various socioeconomic variables is still in progress. Each new finding raises new questions, and the answers frequently require a search for new data sets or the construction of new variables from the existing data sets. Many of the new issues point to the need to bring intergenerational variables to bear on the analysis. Some of the progress along these lines has been made in the study of the Trinidad data. Work has been initiated that links data on height in other samples with genealogies and with census data on the households in which the persons measured were raised. This work makes it possible to investigate the influence of the nutritional status of parents and grandparents on the health and productivity of their children and grandchildren.[5]

[4] It has sometimes been argued that it is impossible to separate, by statistical analyses, the effect on growth of disease and of a generally inadequate level of food intake. This argument assumes a much higher level of collinearity than actually exists. It is true that the body draws more heavily on nutritional stores when it is fighting an infection than when it is not, so that an infection may cause growth to cease during a period of infection. However, as Nevin S. Scrimshaw has pointed out, if a child is normally well fed, and if there is sufficient time between infectious episodes, there will usually be full catch-up when an infection ceases. Normal, well-fed children do not grow at equal daily rates but alternate periods of growth well in excess of the daily average, with periods of little or no growth as disease and other claims on nutritional intake wax and wane. In well-fed children, these lacunae in growth have no effect on final heights because of full and rapid catch-up, but in malnourished children, they contribute to permanent stunting.

[5] Cf. Chapter 4 and Chandra (1975), Tanner (1990), and Barker (1998). In the case of the Civil War data set, recruits have been linked with pension records that give pensioners' medical histories (including degrees of impairment of productivity at various