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3 Health, Height, and Welfare: Britain, 1700–1980

Roderick Floud and Bernard Harris

In recent years, an increasing number of historians have combed the records of military recruiting officers, convict ships, prison officers, and local education authorities to examine the impact of economic and social change on the height of the British population during the last three centuries. Although this work was originally inspired by an investigation into the causes of mortality decline in North America, it soon became apparent that the historical analysis of human height could offer new insights into the long-running controversy over the standard of living during the industrial revolution, and the techniques developed during these investigations were also applied to debates over the demographic impact of the First World War and the impact of the interwar recession (Fogel et al. 1978; Floud, Wachter, and Gregory 1990; Harris 1988, 1993). The most comprehensive account of long-term trends in the height of the British population was provided by Roderick Floud, Kenneth Wachter, and Annabel Gregory, but their work has since been challenged and extended by a long list of other authors (see, e.g., Komlos 1993a, 1993b, 1993c; Mokyr and Ó Gráda 1994; Nicholas and Steckel 1991; Nicholas and Oxley 1993; Riggs 1994). As a result, it is probably fair to say that more attention has been devoted to changes in the height of the British population than to those of any other population group.

The aim of this paper is to synthesize some of this evidence against the background of the history of British industrialization and its impact on the health and welfare of the mass of the population since circa 1750. Sections 3.1

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and 3.2 are concerned with the pace and timing of the "industrial revolution" and with its effects on real wage rates, mortality, and literacy. Section 3.3 summarizes the current literature on changes in human stature during the eighteenth and nineteenth centuries, while section 3.4 extends this analysis into the twentieth century. Section 3.5 seeks to combine a range of "human development indicators" into a composite index of changes in human welfare in Britain between 1839 and 1914. The final section summarizes the main conclusions of the paper and suggests some lines for further research.

3.1 The Origins of British Industrialization

Although this paper is primarily concerned with the impact of industrialization on welfare since the mid-eighteenth century, it is appropriate to begin with a brief account of the origins and nature of Britain's industrial revolution. For many years, historians used the term "industrial revolution" to describe a rapid and fundamental transformation in the development of the British economy between, say, 1760 and 1840 (see, e.g., Toynbee 1884). However, in recent years, historians have questioned the traditional image of "an industrial revolution, tied directly to radical changes in methods of production, having their decisive consequences over a relatively short period of time" (Lee 1986, 18). The "new economic historians" in particular have argued that the roots of Britain's industrial growth must be sought in the seventeenth and early eighteenth centuries, and that their impact was slower and more patchy than previously thought (Crafts 1994, 47).

This transformation in our understanding of the origins of the industrial revolution has led to a renewed interest in the pattern of economic growth throughout the eighteenth century. In contrast to many earlier accounts, it is now argued that the eighteenth-century economy was rather more buoyant than historians once believed. This was particularly true of British agriculture, where—according to the latest estimates—agricultural productivity increased by between 0.1 and 0.6 percent per annum between 1700 and 1800 (Allen 1994, 111). The eighteenth century also witnessed a significant increase in per capita incomes, although the effects of this may have been at least partially offset by a parallel increase in income inequality (McKendrick 1982; Porter 1982, 230–31; Lindert 1994, 378–81). Crafts has estimated that per capita incomes rose by 0.31 percent per annum between 1700 and 1760, by 0.01 percent per annum between 1760 and 1780, and by 0.35 percent per annum between 1780 and 1801 (Crafts 1985a, 45). However, this optimistic assessment has recently been challenged by Komlos, who argued that the British economy experienced an "incipient Malthusian crisis" during the eighteenth century, from which it only emerged at the end of the Napoleonic Wars (Komlos 1989, 1993a, 1993c).

The growing tendency to "backdate" the onset of the industrial revolution

has led some historians to question the validity of the concept altogether, but it is clear that the British economy and society did undergo a number of fundamental changes between 1700 and 1850 (Cameron 1978; Fores 1981). The most obvious and unequivocal change was in the number of people who inhabited the British Isles during this period. The statistics for England alone show that the population increased from 5.06 million in 1701 to 8.66 million in 1801 and 16.74 million in 1851. The population of Scotland increased from 1.1 million in 1700 to 2.1 million in 1821, and the population of Ireland increased from approximately 2 million to approximately 7 million over the same period (Wrigley and Schofield 1981, 208–9; Schofield 1994, 93). The eighteenth and nineteenth centuries also witnessed a profound change in the occupations pursued by the majority of the employed population. In 1700, 61.2 percent of male workers were employed in agriculture and 18.5 percent were employed in industry. By 1840, these figures had changed to 28.6 and 47.3 percent, respectively (Crafts 1994, 45).

The increase in the overall size of the population was reflected in the pace of urbanization. E. A. Wrigley has calculated that the proportion of the population that lived in towns containing more than 5,000 inhabitants increased from 17 percent in 1700 to 27.5 percent in 1801, while the proportion of the population living in towns containing more than 2,500 inhabitants increased from 34 percent to 54 percent between 1801 and 1851 (Wrigley 1987, 170; Thompson 1990, 8). The increase in the proportion of the population who lived in towns was accompanied by a dramatic increase in the size of the towns in which they lived. In 1801 only London had a population of more than 100,000, but this situation changed rapidly as the nineteenth century progressed. By 1851 there were 10 towns with populations over 100,000, and the population of London itself had grown to 2.5 million (Waller 1983, 25; Wohl 1983, 4).

3.2 Industrialization and the Standard of Living

The controversy surrounding the interpretation of changing living standards during the period of the "classic" industrial revolution has been described as "the most sustained single controversy in British economic history" and as "the most contentious issue in economic history" (Mathias 1975, vii; Horrell and Humphries 1995, 90). For much of the twentieth century, the debate has tended to be polarized between conflicting groups of "optimists" and "pessimists," who have often appeared to be divided as much by politics and methodology as by the conclusions they reached (Taylor 1975, xi–xviii). During the 1950s and 1960s the debate was dominated by Max Hartwell and Eric Hobsbawm (Hobsbawm 1957; Hartwell 1961), but in recent years a new generation of historians has entered the fray. During the first half of the 1980s Peter Lindert and Jeffrey Williamson published a series of articles that attempted to combine traditional economic indicators, such as real wages, with more "qualitative"

factors, such as health and mortality, but their efforts have failed to win universal acclaim (Williamson 1982; Lindert and Williamson 1983, 1985a, 1985b; Crafts 1985b; Mokyr 1988).

The controversies that have surrounded this debate are of more than historical interest. Although the debate is primarily concerned with the relationship between economic change and human welfare at a particular point in time, it also raises much broader questions about the way in which we define and measure the "standard of living" (Floud 1984). In this section, we attempt to summarize three of the most important components of the "standard of living" in the form of real wages, mortality, and access to educational opportunities. We shall then be in a better position to present the results of our own investigations into the relationship between industrialization and stature.

3.2.1 The Real Wage Debate

The most obvious starting point for discussions about the impact of industrialization on workers' living standards is provided by information on real wages. During the past 40 years, a great deal of scholarly energy has been devoted to the calculation and refinement of different local series in the hope of constructing a composite picture of national trends (Botham and Hunt 1987; Crafts 1985a, 1985b, 1989; Flinn 1974; Lindert and Williamson 1983, 1985a, 1985b; Phelps Brown and Hopkins 1956; Schwarz 1985, 1990; von Tunzelmann 1979). The task has been complicated by the fact that we still know relatively little about the movement of wages and prices or the precise details of individual consumption patterns (Floud et al. 1990, 281–82).

Nevertheless, there is now a general consensus that the real wages of the majority of manual workers increased during the first half of the eighteenth century, either stagnated or declined during the second half of the eighteenth century, and then began to rise once more at some point between 1800 and 1820 (Lindert 1994, 369–71).

Two of the most important recent attempts to investigate trends in real wages are those made by Lindert and Williamson in 1983 and Schwarz in 1985. Lindert and Williamson calculated wage rates for a range of workers at various periods between 1755 and 1851. They found that there was little evidence of any significant change in real wage rates for blue- or white-collar workers in the period between 1755 and 1819 but that real wages rose substantially between 1819 and 1851 (Lindert and Williamson 1983, 12–13). Schwarz calculated trends in the real wages of London bricklayers from 1700 to 1860 (see fig. 3.1). His findings suggested that real wages rose between 1700 and 1720 and leveled off between 1720 and 1750. They fell sharply between 1750 and 1800 and rose between 1800 and 1860 (Schwarz 1985, 28).

One of the biggest difficulties associated with the interpretation of real wage statistics is the difficulty of making sufficient adjustments for variations in unemployment and in female labor force participation rates. However, in 1983 Lindert and Williamson calculated that the national unemployment rate would

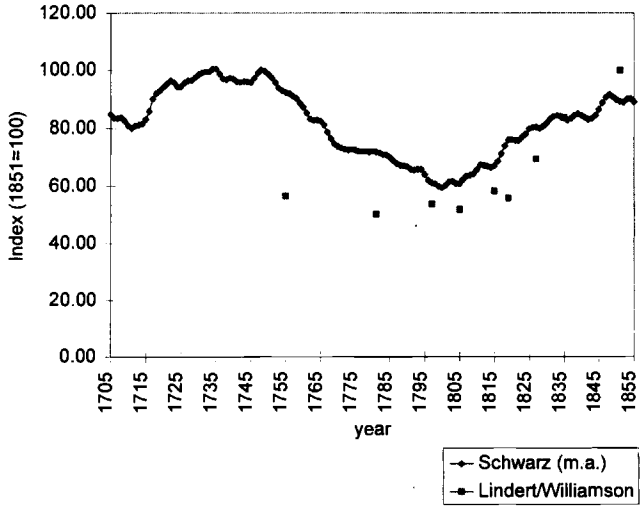

Fig. 3.1 Real wages, 1705–1855
Sources: Lindert and Williamson (1983) and Schwarz (1985).
Notes: Schwarz (m.a.): 11-year moving average of London bricklayers' nominal wages deflated by the Phelps Brown and Hopkins price index.

have had to rise from zero percent to 50 percent, or from 10 percent to 55 percent, to obliterate the increased value of real wages between 1819 and 1851 (Lindert and Williamson 1983, 13). In a more recent publication, Peter Lindert has argued that unemployment would have needed to rise from zero percent to 34 percent to cancel out the effects of increased real wages (Lindert 1994, 373). However, although the margin of error appears to be narrowing, it is still difficult to believe that employment opportunities could have deteriorated by a sufficient amount to overturn the authors' basic contention (Burnett 1994).

So far as women's employment is concerned, Lindert suggested that women's wages either stagnated or declined as a percentage of male wages between 1750 and 1820, and that they rose less rapidly than male wage rates between 1820 and 1850 (Lindert 1994, 375). However, Lindert made relatively little effort to consider the impact of changes in the female labor force participation ratio or in the population's age structure (see also Joyce 1990, 139; Bythell 1993, 49; Horrell and Humphries 1995, 89–90). In 1995 Horrell and Humphries calculated that the percentage of married women who were active in the labor force declined from 61.7 percent between 1821 and 1840 to 45.3 percent between 1846 and 1865, while in 1981 Wrigley and Schofield estimated that the dependency ratio (the ratio of people of nonworking age to people of working age) rose from 699:1,000 in 1751 to 744:1,000 in 1851 (Horrell and Humphries 1995, 98; Wrigley and Schofield 1981, 216–19, 528–29; see also Anderson 1990, 38). Taken together, these statistics suggest that the impact of

increases in the real value of male wages may have been at least partially offset by the increased number of nonearners who depended on each breadwinner.

3.2.2 Industrialization and Mortality

Critics of Britain's industrialization have often argued that such increases in incomes as did occur were bought at the cost of reductions in health and longevity (Lindert 1994, 361–64). In 1833 one of the factory commissioners, Dr. Bisset Hawkins, claimed that "most travellers are struck by the lowness of stature, the leanness and paleness which present themselves so commonly to the eye at Manchester, and above all, among the factory classes," while an investigation into the physical condition of the handloom weavers in 1840 concluded that "they are decayed in their bodies; the whole race of them is rapidly descending to the size of Lilliputians" (Flinn 1965, 247, 251–52). In 1845 Friedrich Engels alleged that English society "daily and hourly commits what the workingmen's organs, with perfect correctness, characterise as social murder" because "it has placed the workers under conditions in which they can neither retain health nor live long" (Engels 1969, 127).

The essential starting point for any discussion of demographic trends in the eighteenth and nineteenth centuries is Wrigley and Schofield's *Population History of England* (1981). Wrigley and Schofield showed that the crude mortality rate for the population as a whole fluctuated sharply during the first half of the eighteenth century (though less sharply than in the preceding centuries), before falling between circa 1780 and 1830. However, the aggregate mortality rate leveled off during the middle years of the nineteenth century and only resumed its downward path during the 1870s (Wrigley and Schofield 1981, 228–36). This interpretation is supported by the statistics collected by the registrar-general for the whole of England and Wales from 1838 onward. The registrar-general's calculations suggest that aggregate mortality rates averaged about 21–23 deaths per 1,000 living between the 1840s and 1860s, before falling to 14 per 1,000 in 1914 (fig. 3.2).

It is usual for demographers to measure mortality in terms of the number of people dying from a particular cause at a particular point in time, but it is also possible to compare the mortality experience of different birth cohorts. In 1934, Kermack, McKendrick, and McKinley examined the pattern of mortality decline among different age groups during each decade from 1841–50 to 1921–30, finding that each generation or cohort carried with it the same relative mortality throughout life (Kermack, McKendrick, and McKinley 1934; Kuh and Davey Smith 1993, 108–9). This argument derives considerable support from table 3.1, which shows that the process of mortality decline began with those aged 5–24, before spreading to those aged 0–4, then to those aged 25–64, and finally to those aged 65 and over. The largest reductions in mortality, in percentage terms, occurred among those aged 5–24. According to Wohl, the general death rate declined between 1841–50 and 1891–1900 by over 12 percent among those aged 0–4, by over 50 percent among those aged 5–24, by

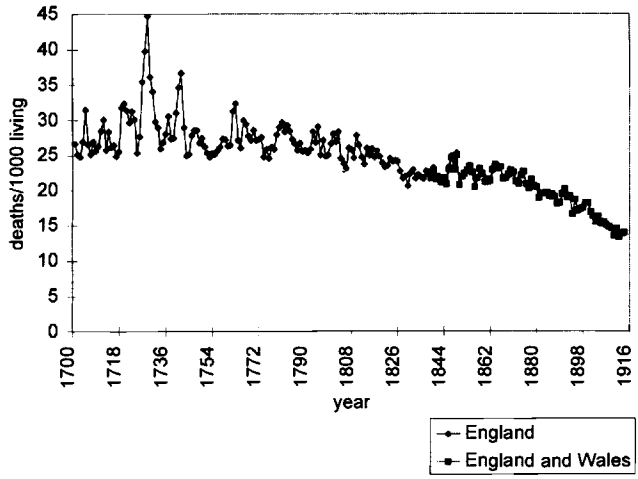

Fig. 3.2 Crude death rates: England, 1701–1871; England and Wales, 1838–1914

Sources: Wrigley and Schofield (1981, table A3.3) and Mitchell (1988, 57–59).

almost 38 percent among those aged 25–34, and by almost 19 percent among those aged 35–44 (Wohl 1983, 329).

The aggregate mortality rate concealed important regional variations. It is well known that urban mortality rates were generally higher than rural mortality rates, and that an increasing proportion of the British population was living under urban conditions. However, there is evidence that mortality rates *within* urban areas may actually have been improving. In 1983 Lindert and Williamson claimed that mortality rates declined within both urban and rural areas from about 1800 onward, with the possible exception of mortality rates in Liverpool and Manchester (Lindert and Williamson 1983, 21). This impression was reinforced by Robert Woods's investigations into the trends in both urban and rural mortality rates during the whole of the nineteenth century. Woods found that life expectancy improved in both urban and rural areas from the early nineteenth century onward, but that the improvement in life expectancy in the most populous areas was much more marked after 1860 (Woods 1985, 650).

The analysis of trends in mortality rates has a number of implications for the earlier discussion of trends in real wage rates. The fact that the decline of mortality was arrested between circa 1830 and circa 1870 provides strong evidence in support of the view that any wage increases that did occur were bought at a high price in terms of health and mortality. At the same time, the fact that mortality rates continued to decline *within* urban areas suggests that even though urban areas were less healthy than rural areas, there was no absolute decline in the living standards of those who already lived in these areas.

Table 3.1 **England and Wales: Age-Specific Mortality Rates (Males), 1838–42 to 1908–12**

	Ages											
Years	0–4	5–9	10–14	15–19	20–24	25–34	35–44	45–54	55–64	65–74	75–84	85+
1838–42	71.34	9.52	5.18	7.24	9.34	9.92	12.58	17.88	31.60	65.56	144.12	304.60
1843–47	71.68	8.70	4.94	7.02	9.54	9.80	12.78	17.92	31.52	68.36	151.00	323.22
1848–52	72.66	9.50	5.32	7.04	9.46	10.16	13.10	18.70	31.86	66.06	144.82	297.34
1853–57	72.24	8.22	4.96	6.80	9.02	9.78	12.68	18.22	31.20	66.08	149.38	312.76
1858–62	72.02	8.18	4.52	6.38	8.36	9.18	12.34	17.80	31.08	65.28	144.96	309.94
1863–67	74.56	8.50	4.64	6.36	8.88	10.24	13.92	19.76	33.96	68.00	149.14	325.12
1868–72	71.92	8.06	4.30	5.98	8.36	10.22	13.78	19.44	33.10	66.96	145.16	303.36
1873–77	68.32	6.54	3.68	5.28	7.38	9.44	14.08	20.36	35.32	70.48	150.72	327.80
1878–82	64.76	6.28	3.32	4.64	6.26	8.36	13.00	19.56	34.68	69.10	150.68	322.18
1883–87	62.70	5.40	3.02	4.40	5.82	7.84	12.46	19.26	34.54	70.92	149.12	311.74
1888–92	61.88	4.76	2.66	4.08	5.40	7.42	12.34	20.24	36.80	74.48	151.84	310.46
1893–97	62.28	4.34	2.46	3.80	5.00	6.60	11.14	18.14	33.28	66.86	138.90	269.30
1898–1902	60.30	4.00	2.26	3.52	4.84	6.42	11.00	18.50	34.52	69.42	144.52	287.10
1903–7	51.64	3.48	2.04	3.08	4.16	5.62	9.18	16.28	32.02	64.32	137.16	283.26
1908–12	42.38	3.26	1.96	2.92	3.80	5.00	8.20	15.00	30.18	63.92	138.02	272.30

Source: Mitchell (1988, 60–62).

The main reason for the arrest of progress in the decline of mortality was not a deterioration in the living standards of those who lived in towns, but the disproportionate increase in the size of the urban population. This meant that even though the average level of real wages was increasing, a growing proportion of the population was being subjected to the unhealthy conditions of town life.

3.2.3 Education and Literacy

A third issue that has attracted considerable attention in debates about the standard of living is the question of educational opportunity and literacy. Many nineteenth-century commentators argued that public provision of educational services was necessary either as a means of enforcing "social control" or as a means of improving economic efficiency, but access to education is also an important component of the standard of living (Sanderson 1991; Sutherland 1990). It is often the key to social mobility. It broadens horizons, encourages the communication of ideas, and facilitates political activity.

Historians who have studied changes in educational standards have tended to concentrate on two sets of statistics: school attendance and literacy. E. G. West (1970) examined the number of schools built, and the number of scholars in attendance, in a number of early-nineteenth-century towns, but his conclusions have not been widely accepted (Sutherland 1990, 121). The majority of educational historians believe that formal educational opportunities expanded during the first two-thirds of the eighteenth century because the growth in the number of schools outstripped that of the population as a whole, but this situation was reversed during the years of more rapid population growth between 1780 and 1830. The expansion of educational opportunities was also halted by the increase in child labor, particularly in the industrial areas of northwest England. According to Michael Sanderson, children's access to education was limited by the need to contribute to the family's income and because the changing nature of child employment provided fewer opportunities for educational advancement (Sanderson 1991, 13).

The divergence of opinions over school provision is also reflected in debates about adult literacy. It is generally accepted that literacy rates rose during the first two-thirds of the eighteenth century, but opinions differ about the period between 1780 and 1850. In 1969 Lawrence Stone argued that the majority of areas witnessed an increase in literacy levels over the whole of the period, but Michael Sanderson has argued that many industrial areas experienced a decline in general literacy between circa 1750 and 1810. The most comprehensive national survey of changing literacy rates was conducted by Roger Schofield in 1973. Schofield found that literacy levels rose very slowly between 1750 and 1840, and that more than half the population was still functionally illiterate in the middle of the nineteenth century. Schofield also found that literacy levels were higher in rural areas than in industrial areas, but he rejected the view that this reflected a collapse in educational opportunities in industrial areas. He

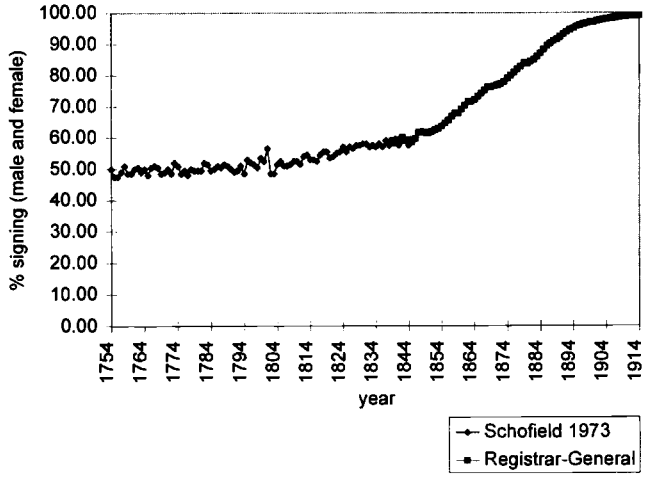

Fig. 3.3 Percentage of marriage partners signing their names, 1754–1914
Sources: Data for 1754–1844 are based on Schofield (1973, 445); data for 1839–1914 are derived from the *Annual Reports of the Registrar-General for England and Wales, 1839–1914.* The authors are grateful to Roger Schofield for supplying the original data on which his calculations were based.

argued that literacy rates in industrial towns were often low because illiterate workers moved from agricultural areas to industrial areas in search of jobs that did not require literacy skills (Schofield 1973).

One of the biggest problems associated with this debate concerns the nature of the evidence on which it is based. The majority of historians have based their conclusions on the numbers of men and women who signed their names on marriage registers (cf. Nicholas 1990). As Gillian Sutherland has pointed out, this may be a misleading guide to the level of literacy in the population as a whole (or, at least, in that section of the population that is getting married) because many people may have been able to read even though they were unable to sign their own names (Sutherland 1990, 124–25). We cannot rule out the possibility that the earlier figures underestimate the real level of literacy in preindustrial and industrializing England, and that the dramatic improvement in the number of men and women who were able to sign their own names between 1850 and 1914 reflects a change in attitudes to the acquisition of *writing* skills as well as an improvement in literacy as a whole (fig. 3.3).

3.3 Industrialization and Stature

The continuing debates about the movement of real wages, mortality rates, and literacy trends illustrate the depth of interest that continues to be aroused by the debate over the standard of living during the industrial revolution, but

they also provide a further illustration of the difficulties raised by this debate (Floud 1984). It is in this context that a number of historians have begun to focus on changes in human stature during this period. It is well known that the heights of both adults and children are responsive to a wide range of environmental and nutritional influences, including both dietary inputs and environmental and epidemiological demands (Eveleth and Tanner 1991, 1; Komlos 1994, x–xi). However, it is also clear that the delineation and interpretation of trends in average height is itself becoming increasingly controversial. We shall therefore begin by reviewing some of the latest evidence on trends in average stature during the eighteenth and nineteenth centuries.

The most obvious starting point for this analysis is Floud et al's (1990) study *Height, Health and History*. This work was based on an analysis of changes in the heights of poor boys recruited by the Marine Society of London between 1770 and 1870, and of men who were recruited by the Royal Marines and the British Army between 1740 and 1914. These data were supplemented by information about the heights of upper-class recruits attending the Royal Military Academy at Sandhurst from 1806 onward (Floud and Wachter 1982; Floud et al. 1990, 128–33).

The results of Floud et al.'s analysis of the military recruiting data are shown in figure 3.4. These graphs suggest that the average heights of successive birth cohorts of British males increased between the 1740s and 1760s and fell back between the 1760s and the 1780s. The average heights of successive birth cohorts also increased between the late 1780s and the 1820s and declined between the 1820s and 1840s. The average heights of successive birth cohorts of British men only began to increase consistently from the 1840s onward (fig. 3.4). Floud et al. also expressed concern about the size of the samples at the beginning of their period, and this led them to "smooth" the data with the aid of Cleveland's "locally weighted scatterplot smoother." The application of this procedure led them to conclude that, on average, the heights of successive birth cohorts of British males rose between 1740 and 1840, fell between 1840 and 1850, and rose once more from 1850 onward (Floud et al. 1990, 136–54, 325).

Floud et al. supplemented their analysis of trends in aggregate heights by examining changes in the pattern of regional and socioeconomic height differentials. One of their most striking findings was the discovery that, in the early part of the nineteenth century, men who lived in Scotland and the north of England were between 1.0 and 1.5 cm taller than men who lived in London and the southeast, a pattern that has been almost entirely reversed over the last 150 years (Floud et al. 1990, 200–206; Knight and Eldridge 1984). Floud et al. also showed that men who grew up in urban areas were shorter than men who grew up in rural areas, and that there were significant differences in the heights of men and boys from different socioeconomic backgrounds. At the beginning of the nineteenth century, 14-year-old boys attending the Royal Military Academy at Sandhurst were nearly six inches taller than their counterparts in the Marine Society, and there were still considerable differences in the

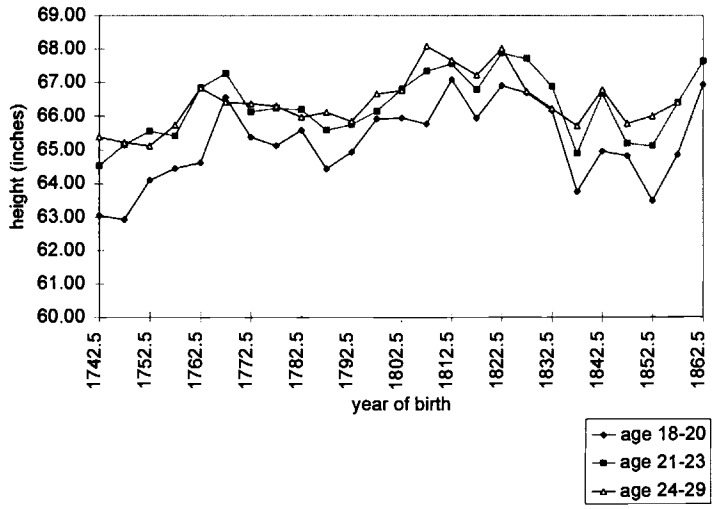

Fig. 3.4 Mean heights of military recruits aged 18–29, by year of birth
Source: Harris (1994a, 311).

heights of children from different social backgrounds a hundred years later (Floud et al. 1990, 196–200).

The most controversial aspect of Floud et al.'s work concerned their delineation of trends in the average height of British males in the eighteenth and early nineteenth centuries. They argued that "the early part of the industrial revolution led to an absolute as well as relative increase in the welfare and nutritional status of the working class, but . . . the impact of urban growth eroded that increase and even led to decreases in average height as large proportions of the working class were subjected to town life" (Floud et al. 1990, 326). However, these conclusions have been subjected to a variety of criticisms. In 1993 John Komlos criticized the statistical procedures followed by Floud et al. and reworked their data to show that the average height of British males deteriorated throughout the second half of the eighteenth century (Komlos 1993c). His account of changes in the average height of the British population was supported in different ways by the work of Nicholas and Steckel (1991), Nicholas and Oxley (1993), and Riggs (1994).

In their reply to Komlos, Floud et al. identified four key areas of disagreement. Komlos argued that Britain experienced an "incipient Malthusian crisis" during the second half of the eighteenth century, and that Floud et al. were wrong to "pool" the data derived from the army recruiting records and the Royal Marines. He also criticized their use of the Lowess smoothing procedure and reworked their original data using a procedure developed by Komlos and Kim three years earlier (Floud, Wachter, and Gregory 1993; Komlos and Kim 1990). We agree that the application of the Lowess smoothing procedure may

have been overcautious, and that the average height of British men decreased as well as increased during the course of the eighteenth century, but we still believe that the overall trend was upward rather than downward. We also believe that the decision to pool the data from the army and marine records was justified because the two organizations derived their recruits from the same population even though they operated different height standards. Finally, even though we believe that the estimating procedure developed by Komlos and Kim is a valuable addition to the literature of anthropometric history, we do not think that it is capable of supporting the conclusions that have been derived from it in this instance.

The conclusions presented by Floud et al. have also been challenged by Stephen Nicholas and Richard Steckel. Nicholas and Steckel contrasted Floud et al.'s analysis of the military data with new data derived from the heights of English and Irish convicts who were transported to Australia between 1817 and 1840 (Nicholas and Steckel 1991). Their results are clearly important, and they are reproduced, together with Komlos's estimates, in table 3.2. However, although the numbers in this table suggest that the average height of English workers may have declined after 1780, we believe that more work needs to be done to establish the representativeness of the convict data (see also Shlomowitz 1990, 1991; Nicholas 1991a, 1991b). We also feel that more work is needed to explain the discrepancies between Nicholas and Steckel's analysis of changes in the average heights of male convicts and Nicholas and Oxley's analysis of changes in the heights of female convicts who were drawn from a similar sample (Nicholas and Oxley 1993).

Floud et al.'s second major finding was that there was a decline in the average heights of men born during the second quarter of the nineteenth century. The findings themselves have been challenged by Riley (1994), and the conclusions drawn from them have been criticized by Crafts (1992). In 1994, Riley argued on the basis of a contemporary anthropological survey that there was no evidence of any trend in the average heights of men born between 1817 and 1841 (Riley 1994, 477). However, his findings were based on a comparatively small sample, and they did not all point in the same direction. It is particularly interesting to note that when Riley reallocated his subjects into subgroups of English, Scots, and Welsh, "only the English . . . exhibited a strong change in height with age" (Riley 1994, 481). There is also a mounting volume of evidence from other studies that suggests that average heights did decline during the second quarter of the nineteenth century. Paul Riggs has shown that there was a decline in the average heights of Scottish men and women who were born between 1800 and 1840, and Paul Johnson and Stephen Nicholas have found evidence of a decline in the heights of "habitual criminals" who were born between 1812 and 1857 (Riggs 1994, 70–73; Johnson and Nicholas 1995).

Crafts's objections raise a more fundamental challenge to the practice of anthropometric history. He accepted that there was a decline in the average

Table 3.2 **Estimated Trends in Heights of Different Groups of English-Born Workers, 1710–1815 (height in inches)**

Period of Birth	Convicts (1)	Indentured Servants (2)	13-Year-Old Boys (3)	14-Year-Old Boys (4)	Urban Convicts (male) (5)	Rural Convicts (male) (6)	Urban Convicts (female) (7)	Rural Convicts (female) (8)
1710–19		67.40						
1720–29	67.90	67.40						
1730–39	67.83	66.70						
1740–49	67.58	66.75						
1750–59	67.79	66.88	51.57	54.41				
1760–69			50.67	53.46				
1770–79			51.54	53.39				
1780–84					66.40	66.42		
1785–89					66.11	65.83		
1780–89			51.38	53.27				
1790–94					65.94	65.78		
1795–99					65.94	65.72	60.72	61.38
1790–99			51.54	52.40				
1800–1804					66.12	65.41	60.59	61.55
1805–9					65.81	65.43	60.76	61.65
1800–1809			51.50	51.97				
1810–14					66.48	65.87	60.39	61.08
1815+					65.46	65.40	60.44	61.72

Sources: Cols. (1) and (2), Komlos (1993b, 775); cols. (3) and (4), Komlos (1993c, 128); cols. (5) and (6), Nicholas and Steckel (1991, 952); cols. (7) and (8), Nicholas and Oxley (1993, 742).

height of the British population but challenged the conclusions that Floud et al. derived from it. He argued that there was "no justification at all" for the claim that average heights deteriorated as a result of environmental demands "as no way of measuring the exchange rate of height for real income has yet been devised" (Crafts 1992, 428). However, although we agree that the "exchange rate of height for real income" remains uncertain, we do not believe that this invalidates our research. The claim that the average height of British men declined as a result of urban conditions is based on the clearly observed fact that urban-born men were shorter than rural-born men, and that an increasing proportion of the national population was being born in urban areas. Floud et al. also showed that the bulk of the decline in average heights was concentrated in urban areas between circa 1820 and circa 1860 (Floud et al. 1990, 206–7). Under these circumstances, it does not seem unreasonable to suggest that the unhealthy disease environment of Britain's cities was primarily responsible for the decline in the average height of men who were born during this period.[1]

3.4 Height and Social Change in the Twentieth Century

Most of the research that has been undertaken into the height of British people during the eighteenth and nineteenth centuries has focused on the heights of adults, but there have also been a number of investigations into the heights of children. The authors of *Height, Health and History* examined changes in the heights of poor boys who were recruited by the Marine Society of London and compared their heights with those of upper-class boys at the Royal Military Academy (Floud and Wachter 1982; Floud et al. 1990, 163–75). Jordan has collected data from a number of contemporary studies to depict changes in the heights of both working-class and non-working-class children of both sexes between 1807 and 1913 (Jordan 1993). In general, these studies confirm the pattern of change that Floud et al. found among military recruits. The average heights of successive birth cohorts fell during the second quarter of the nineteenth century and increased slowly from the 1850s onward (Floud et al. 1990, 165–71; Jordan 1993, 137).

In contrast to the eighteenth and nineteenth centuries, the study of children's heights has loomed much larger in the anthropometric history of the twentieth century. In 1936 Karn discussed changes in the heights of children who were born between 1820 and 1920, and in 1952 Weir examined trends in the heights of children who were measured between 1906 and 1949 (Karn 1936; Weir 1952). These studies were followed by Clements's account of changes in the heights of children between 1880 and 1947, and by Boyne, Aitken, and Leitch's

1. It is difficult to make more precise statements about the differences between urban and rural areas because of the size of the samples needed to make such statements (see Floud et al. 1990, 201–2). For an alternative explanation of "urban disamenities," see Clark, Huberman, and Lindert (1995).

much larger survey of the heights of children between 1911 and 1953 (Clements 1953; Boyne, Aitken, and Leitch 1957; see also Leitch and Boyne 1960). The most comprehensive study of changes in the average heights of children was conducted by Harris in 1989. Harris used the records of individual school medical officers to assemble data on the heights of children in over 50 areas and examined a number of different issues, including the impact of the First World War between 1914 and 1918, and the impact of unemployment between 1918 and 1939 (Harris 1988, 1989, 1993, 1994b, 1995).

The basic results of Harris's survey are shown in table 3.3. The table shows the average height of five-year-old boys in different parts of Great Britain between 1908 and 1950. The figures show that every area witnessed an increase in the average value of children's heights during the course of the period, although the pace and timing of these changes varied from area to area. The average heights of five-year-old boys in Cambridge, Croydon, Leeds, Rhondda, and Warrington increased by between 2.0 and 2.9 inches between 1908 and 1950. The average heights of boys in Bradford increased by 1.9 inches between 1908 and 1938, while the average heights of boys in Huddersfield increased by 1.8 inches between 1918 and 1949. Similar increases were also recorded in Glasgow between 1921 and 1949, in Reading between 1921 and 1937, and in Wakefield between 1932 and 1949 (table 3.3).

The data on the heights of schoolchildren can also be used to shed light on the question of gender differences in height, or "sexual dimorphism in stature." In recent years a number of writers have examined long-term trends in the heights of boys and girls to establish whether girls are more resistant to adverse influences than boys, and to see whether there is any systematic evidence of female neglect (Kuh, Power, and Rodgers 1991; Nicholas and Oxley 1993). Our findings suggest that there was very little difference between the general trends in the heights of boys and girls in either prosperous or depressed areas; this tends to contradict the view that female children experienced systematic neglect in poor families (figs. 3.5 and 3.6). The figures also suggest that past generations of girls may have been slightly taller, in comparison with past generations of boys, when their heights are compared with those of children of the same age and sex today. This tends to support the view that past generations of girls were more resistant to adverse influences than their male siblings (Tanner 1962, 127–28; see also Brennan, McDonald, and Shlomowitz 1994, 166).

In addition to these general trends, it is also possible to conduct a much more detailed examination of changes in the average height of different groups of schoolchildren during particular periods. In 1993 Harris examined the heights of children in 24 areas to see whether the First World War had any systematic impact on the heights of children who were measured between 1914 and 1918. Winter had claimed in 1986 that the war led to the most dramatic improvements in the standard of public health in the first 30 years of the twentieth century, but Harris's analysis of both the height data and the statistics of infant mortality suggested that this conclusion was somewhat overoptimistic

Table 3.3 Changes in Average Height of Five-Year-Old Boys, 1908–50

Area	Year	Average Age	Height (inches)	Height[a] (centiles)
Bradford	1908	5.50	40.31	3.21
	1922	5.50	41.34	9.35
	1938	5.50	42.24	19.61
Cambridge	1908	5.50	40.44	3.73
	1921	5.50	41.21	8.28
	1938	5.50	43.35	38.84
	1949	5.50	43.29	37.66
Croydon	1908	5.50	41.00	6.75
	1922[b]	5.50	42.40	21.97
	1938	5.50	43.10	34.00
	1950	5.50	43.40	39.83
Glasgow	1921	5.25	40.20	6.21
	1938	5.33	41.70	18.81
	1949	5.33	42.39	29.44
Huddersfield	1918	5.50	41.49	10.71
	1938	5.50	43.06	33.25
	1949	5.50	43.31	38.05
Leeds	1909	5.50	40.20	2.82
	1921	5.50	41.00	6.75
	1939	5.50	42.10	17.67
	1946	5.50	42.30	20.48
Reading	1921	5.00	40.75	15.61
	1937	5.00	41.75	31.71
Rhondda	1912	5.50	40.20	2.82
	1922	5.50	40.75	3.38
	1938	5.50	41.91	15.25
	1945	5.50	42.20	19.04
Wakefield	1932	5.25	40.75	10.42
	1938	5.25	41.25	15.73
	1949	5.25	41.75	22.65
Warrington	1911	5.00	39.00	2.58
	1939	5.00	41.40	25.36
	1944	5.00	41.20	22.06

Source: Harris (1989, 218–48).

[a]The numbers in this column show the average value of the heights of five-year-old boys expressed as centiles of the distribution of the heights of five-year-old boys in London in 1965.

[b]The figures for Croydon in 1922 are based on the heights of an unknown number of children attending 10 unnamed schools in the area.

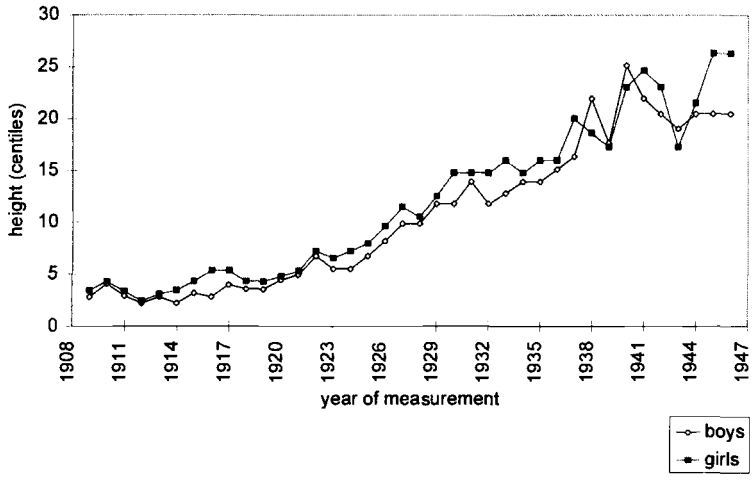

Fig. 3.5 Average heights (in centiles) of five-year-olds in Leeds, 1909–46
Source: See appendix table 3A.2.

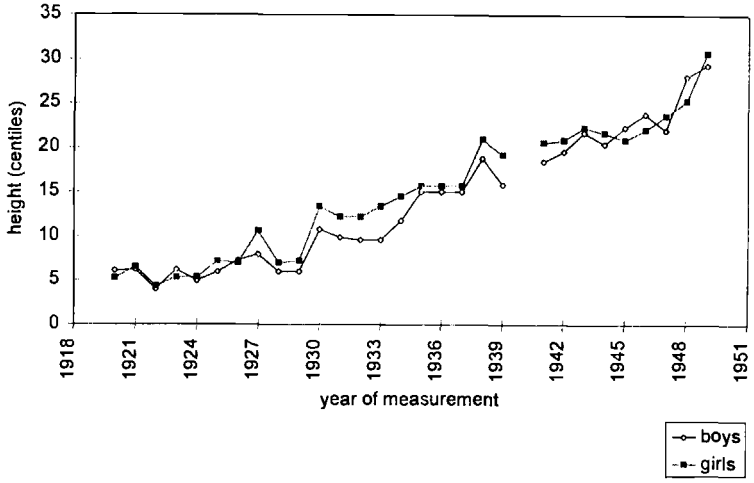

Fig. 3.6 Average heights (in centiles) of five-year-olds in Glasgow, 1920–49
Source: See appendix table 3A.2.

(Winter 1986; Harris 1993). Harris concluded that the average value of children's heights increased in some areas and decreased in others, but that the overall impact of these changes was not very great (Harris 1993, 359–64).

The second major focus of research concerned the impact of unemployment on children's heights during the interwar recession. In 1988 Harris divided the data for 11 areas into three different groups and found that changes in the average rate of adult male unemployment were related to changes in the aver-

Table 3.4 **Effect of Changes in Average Rate of Adult Male Unemployment (ΔU) on Changes in Average Value of Children's Heights (ΔH) in Individual Areas, 1927–37**

Area	Period	Constant	ΔU_{-1}	R^2	d^*	Sig. F
Blackburn	1928–37	1.18	−0.32	0.28	1.66	0.02
Bradford	1927–37	0.74	−1.45	0.70	0.75	0.00
Cambridge	1926–37	1.64	−4.54	0.40	0.77	0.03
Croydon	1930–37	0.74	−0.14	0.00	3.46	0.92
Glasgow	1926–37	0.71	−0.05	0.01	1.59	0.72
Huddersfield	1926–37	1.00	−1.28	0.72	1.45	0.00
Leeds	1926–37	0.78	−0.55	0.57	2.04	0.00
Reading	1926–37	1.08	0.41	0.02	2.79	0.67
Rhondda	1926–37	0.77	−0.17	0.26	1.85	0.09
Wakefield	1931–37	0.64	−0.31	0.55	2.15	0.06
Warrington	1926–37	1.34	−0.07	0.01	1.54	0.80
Area	Period	Constant	ΔU_{-2}	R^2	d^*	Sig. F
Blackburn	1928–37	1.11	−0.06	0.01	1.20	0.78
Bradford	1927–37	0.77	−0.98	0.29	0.59	0.09
Cambridge	1927–37	1.66	−5.09	0.50	0.90	0.02
Croydon	1930–37	0.81	−0.84	0.07	3.59	0.54
Glasgow	1927–37	0.72	−0.11	0.06	1.44	0.47
Huddersfield	1927–37	1.10	−1.35	0.75	2.25	0.00
Leeds	1927–37	0.80	−0.61	0.64	2.36	0.00
Reading	1927–37	1.12	0.47	0.03	2.72	0.64
Rhondda	1927–37	0.80	−0.12	0.11	1.60	0.33
Wakefield	1931–37	0.86	−0.47	0.92	1.72	0.00
Warrington	1927–37	1.32	−0.47	0.35	1.77	0.05

Source: Harris (1994b, 37).

Note: Method was ordinary least squares.

age value of children's heights in some of these areas, but not in others (see table 3.4; Harris 1988; 1989, 271). In 1994 Harris sought to extend this analysis by looking at the relationship between unemployment and stature in each area individually. He found that changes in the average rate of adult male unemployment were related to changes in the average value of children's heights in about half the areas studied, but the size of this relationship was not very great (Harris 1994b, 35–38). His overall conclusion was that unemployment played an important role in exacerbating the hardship that many unemployed people and their families already faced, but that the extent of this relationship varied from area to area. His results also demonstrated the importance of the local context within which unemployment occurred, and the difficulties of disentangling the effects of unemployment from those of poverty and bad housing generally (Harris 1995, 141–42).

In addition to examining changes in the average value of children's heights during the first 40 years of this century, Harris has also examined the changing pattern of children's heights during and after the Second World War. His analy-

sis of changes in the average height of children in 10 areas between 1939 and 1945 confirms the view that there was a definite improvement in the average standard of child health during this period (Harris 1995, 165–71). His findings show that seven areas witnessed consistent improvements in the average height of both boys and girls at all ages, while two areas witnessed a period of deterioration followed by improvement. Only one area failed to produce evidence of an improvement in height, and the data for this area were limited to the period 1939–44 (table 3.5).

Although there was a considerable revival of interest in anthropometric measuring during the late 1930s and early 1940s, very few Local Education Authorities continued to publish tables of average heights and weights after circa 1950. One of the exceptions was Sheffield, which published details of the average heights and weights of all children between 1936 and 1968, and the average heights and weights of children attending schools in different types of district between 1951 and 1968. The second set of figures provides a clear demonstration of the increase in average heights as well as the persistence of health inequalities during the era of the "classic" welfare state (Lowe 1993, 63). This period witnessed an increase in the proportion of children attending schools in "good" and "medium" districts and a decline in the proportion of children attending schools in "poor" districts, but the average height of children attending good and medium schools was greater than the average height of children attending poor schools throughout the period (fig. 3.7).

3.5 Height and Human Development

The preceding sections have examined some of the ways in which studies of adults' and children's heights can be used to shed new light on the history of human welfare in Britain since 1700. However, although there is now a much wider degree of acceptance of the basic principles of anthropometric history, a number of commentators have continued to express reservations about the interpretation of these trends (Tilly, Tilly, and Tilly 1991; Crafts 1992). One of the most important issues concerns the relationship between trends in average height and trends in other welfare measures. In order to try to address this problem, we have attempted to compare our results with those obtained from an analysis of changes in human welfare using a modified version of the UN Human Development Index (United Nations Development Programme 1990–95).

The Human Development Index (HDI) is a composite index that seeks to rank individual countries on the basis of literacy, the logarithm of their GDP per capita, and life expectancy at birth.[2] In order to construct the index, the

2. The HDI uses literacy as a proxy for educational achievement. Strictly speaking, the literacy indicator should be combined with an estimate of mean years of schooling to provide a composite value for this variable. See United Nations Development Programme (1991, 15, 90).

Table 3.5 **Changes in Average Heights of Boys and Girls at Different Ages, 1939–45**

Area	Sex	Age Group	Height (inches)						
			1939	1940	1941	1942	1943	1944	1945
Cambridge	Male	Entrants	43.19	42.85	43.11	43.10	43.26	43.23	43.27
		Intermediates	50.04	49.57	49.85	49.78	49.77	50.02	50.08
		Leavers	56.99	57.09	57.44	57.25	57.94	57.79	57.61
	Female	Entrants	43.10	43.03	42.69	42.75	42.63	42.69	43.26
		Intermediates	49.55	49.34	49.58	49.54	50.71	50.09	49.80
		Leavers	57.97	58.10	58.17	58.18	57.89	58.23	58.20
Croydon	Male	Entrants	41.80	n.a.	n.a.	n.a.	43.20	n.a.	43.30
		Intermediates	49.00	n.a.	n.a.	n.a.	51.10	n.a.	51.30
		Leavers	58.40	n.a.	n.a.	n.a.	58.00	n.a.	58.00
	Female	Entrants	41.20	n.a.	n.a.	n.a.	42.90	n.a.	43.30
		Intermediates	50.90	n.a.	n.a.	n.a.	49.40	n.a.	50.70
		Leavers	58.80	n.a.	n.a.	n.a.	58.90	n.a.	59.00
Dumbartonshire	Male	Entrants	42.43	42.18	42.71	42.71	42.67	42.63	42.66
		Intermediates	49.64	n.a.	49.87	48.63	49.91	49.80	49.81
		Leavers[a]	59.44	59.51	59.02	58.87	58.87	57.99	58.82
	Female	Entrants	42.13	42.68	42.03	42.32	42.40	42.19	42.39
		Intermediates	49.34	49.61	49.61	48.33	49.42	49.23	49.38
		Leavers[a]	60.48	59.68	59.50	59.25	59.20	59.61	59.61
Glasgow	Male	Entrants	41.70	n.a.	42.16	41.99	41.91	41.82	41.95
		Intermediates	50.20	n.a.	50.59	50.88	50.69	50.71	50.93
		Leavers	57.60	n.a.	58.33	58.35	58.39	58.54	58.62
	Female	Entrants	41.50	n.a.	41.84	41.62	41.49	41.45	41.62
		Intermediates	49.80	n.a.	50.66	50.46	50.33	50.26	50.48
		Leavers	58.50	n.a.	58.90	58.89	59.17	59.10	59.30

(continued)

Table 3.5 (continued)

Area	Sex	Age Group	Height (inches)						
			1939	1940	1941	1942	1943	1944	1945
Huddersfield	Male	Entrants	43.00	43.45	43.42	43.38	43.54	44.11	44.00
		Intermediates	49.17	49.26	49.14	49.37	49.65	50.72	50.00
		Leavers	56.52	56.24	56.52	56.79	56.03	57.00	57.91
	Female	Entrants	42.43	42.66	42.16	42.53	41.34	42.00	41.97
		Intermediates	48.86	49.10	48.96	48.76	48.62	49.59	49.21
		Leavers	57.29	57.22	57.01	57.72	57.95	56.52	57.50
Leeds	Male	Entrants	42.10	42.60	42.40	42.30	42.20	42.30	42.30
		Intermediates	48.60	48.90	48.80	48.60	48.60	48.60	49.50
		Leavers	55.60	56.10	56.00	55.90	56.00	56.00	56.20
	Female	Entrants	41.60	42.00	42.10	42.00	41.60	41.90	42.20
		Intermediates	48.20	48.60	48.40	48.60	48.30	48.20	48.60
		Leavers	56.50	56.90	56.70	56.30	56.70	56.50	56.50
Rhondda	Male	Entrants[b]	40.96	40.93	39.97	40.64	40.66	41.36	41.10
		Intermediates	48.34	48.02	48.62	47.66	47.07	48.68	49.12
		Leavers	55.99	56.16	56.00	58.20	56.06	55.92	55.91
	Female	Entrants[b]	40.53	38.69	40.45	40.11	40.25	41.01	40.50
		Intermediates	47.88	48.34	48.39	48.82	48.38	47.58	48.59
		Leavers	56.31	56.81	56.31	55.94	56.22	56.77	56.42
Sheffield	Male	Entrants	42.56	42.68	42.87	42.53	43.14	42.76	42.93
		Intermediates	49.29	49.41	49.45	n.a.	n.a.	n.a.	n.a.
		Leavers[c]	57.80	58.19	58.54	58.27	59.02	58.85	59.10

	Female	Entrants	42.20	42.44	42.60	42.25	42.86	42.46	42.64
		Intermediates	49.17	49.17	49.13	n.a.	n.a.	n.a.	n.a.
		Leavers[c]	58.74	59.33	59.76	59.26	59.96	59.90	60.02
Wakefield	Male	Entrants	41.25	41.75	41.50	41.50	41.25	41.50	41.50
		Intermediates	48.75	49.00	48.50	48.75	48.50	48.75	n.a.
		Leavers	54.00	54.50	54.75	54.25	54.75	54.50	54.75
	Female	Entrants	40.75	41.00	41.25	41.50	41.25	41.25	41.75
		Intermediates	48.50	48.50	48.75	49.00	48.75	49.00	n.a.
		Leavers	54.50	54.75	54.50	54.75	54.75	54.75	55.00
Warrington	Male	Entrants	41.40	41.20	41.30	40.50	41.20	41.20	n.a.
		Intermediates	48.60	48.50	50.20	49.00	48.50	48.60	n.a.
		Leavers	55.50	55.30	56.20	55.90	55.80	56.20	n.a.
	Female	Entrants	41.20	41.10	41.10	41.60	40.90	41.10	n.a.
		Intermediates	48.50	48.30	48.30	48.20	48.10	48.34	n.a.
		Leavers	56.50	56.20	56.30	55.50	56.60	56.60	n.a.

Source: Harris (1995, 167–68).

[a]The apparent decline in the heights of school leavers in Dumbartonshire is probably attributable to a change in the age at which the children were measured.

[b]The figures for "entrants" in Rhondda are based on the average heights of children aged 4–6.

[c]The figures for school leavers in Sheffield are based on the heights of children aged 13–14. The number of children measured in this age group in 1939 was comparatively small.

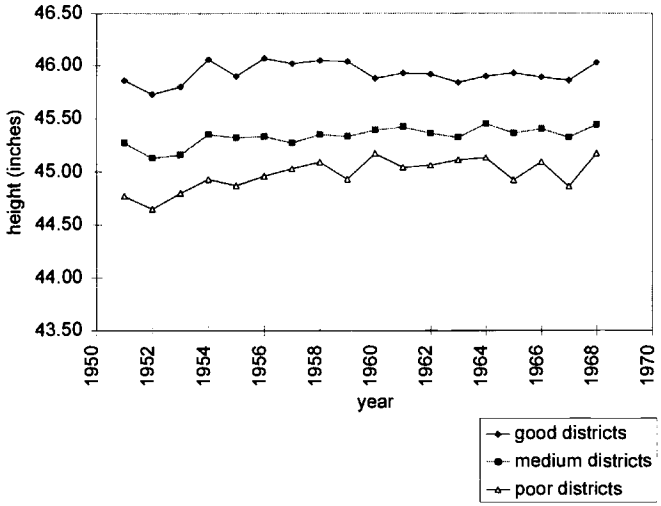

Fig. 3.7 Average heights of six-year-olds in Sheffield, 1951–68
Source: Annual Reports of the School Medical Officer for Sheffield 1951–68.

value of each variable is plotted on a scale of zero to one, where zero is the minimum value of each variable and one the maximum. The HDI itself is equal to the average of the three component variables. In 1990, the United Nations specified minimum values of 42 for life expectancy at birth, zero percent for adult literacy, and U.S.$220 (in 1987 prices) for GDP per capita. The maximum values were 78 years for life expectancy, 100 percent for adult literacy, and U.S.$4,861 for GDP per capita (United Nations Development Programme 1990, 13). In 1994 the United Nations proposed an alternative set of maximum and minimum values that were designed to encompass the broadest possible range of human experience and thus to facilitate comparisons across time. The revised figures are reproduced in table 3.6.

Since its introduction, the concept of a human development index has attracted a great deal of critical attention (see United Nations Development Programme 1993, 104–14). Some of the most important criticisms relate to the choice of dimensions (i.e., health, education, and access to resources) and indicators (expectation of life at birth, adult literacy, and log GDP per capita). The HDI has also been criticized on the grounds that it is based on inaccurate or incomplete statistics, and that its results are overdependent on the choice of maximum and minimum values. Some commentators have also attacked the decision to give each component of the index the same weighting. However, it is clear that there is widespread support for the concept of a human development index, and the United Nations' own investigations do not suggest that any of the proposed modifications would produce a radically different set of outcomes. In view of this, there is a strong case for using the latest formulation of the HDI to investigate the level of human welfare in the past. Such an inves-

Table 3.6 **Maximum and Minimum Values for Variables in the Human Development Index**

Variable	Minimum	Maximum
Expectation of life at birth (years)	25	85
Adult literacy (%)	0	100
GDP per capita (1990 U.S.$)	200	40,000

Source: United Nations Development Programme (1994, 92).

tigation may well shed light on the welfare of past generations and facilitate further debate over the measurement of human development in the present.

In order to apply the concept of the human development index to the welfare of British people over the last 250 years, we have utilized information from a range of sources. Our estimates of life expectancy at birth are based on figures provided by Wrigley and Schofield for England (excluding Monmouth) between 1756 and 1871, and by the registrar-general (for England and Wales) between 1871 and 1980. Our estimates of adult literacy are based on Schofield's figures for 274 English parishes between 1756 and 1838, and on the figures provided by the registrar-general for the whole of England and Wales between 1839 and 1914. It is important to note again that these figures are based on a minimal measure of functional literacy—namely, the ability to sign one's name in a marriage register—and that they represent a very inadequate measure of educational achievement. Our estimates of GDP are based on Crafts's estimates of the growth of Britain's GNP between 1700 and 1831, and on Mitchell's estimates of the United Kingdom's GDP (at market prices) between 1830 and 1980. Our figures have been converted into 1990 U.S. dollars using data provided by the Central Statistical Office, but—unlike the United Nations—we have been unable to make any further adjustments for variations in purchasing power parity (see United Nations Development Programme 1990, 12).[3]

The basic results of our analysis are set out in table 3.7 and are represented graphically in figure 3.8. The results show that there were significant variations in the level and fluctuations of the different series over time. There was little change in the relative value of the different components of the index between the mid-eighteenth and the mid-nineteenth centuries, when the literacy variable was consistently higher than the GDP variable and the GDP variable was consistently higher than the life expectancy variable, but the three series began to show divergent trends from the 1830s onward. The literacy variable began to increase rapidly during the mid-1830s, while the life expectancy variable

3. Full details of the sources used in the construction of the HDI are given in table 3.7. Our original estimates of GDP per capita (in 1990 U.S. dollars) are given in appendix table 3A.3. These estimates are based on an exchange rate of 0.560 pounds to the dollar. Maddison, whose figures are adjusted for variations in purchasing power parity, suggests an exchange rate of 0.587 pounds to the dollar. It is unlikely that these variations would make a significant difference to our overall results. See Maddison (1995, 172, table C-6).

Table 3.7 Changes in the Human Development Index, 1756 to 1978–80

	Original Values			Index Values			
Year	E_0	Literacy (%)	Log GDP per Capita	E_0	Literacy (%)	Log GDP per Capita	HDI
1756	37.29	47.50	3.19	0.20	0.48	0.39	0.36
1761	34.23	50.00	3.19	0.15	0.50	0.39	0.35
1766	35.04	50.50	3.20	0.17	0.51	0.39	0.35
1771	35.60	50.00	3.20	0.18	0.50	0.39	0.36
1776	38.17	49.50	3.20	0.22	0.50	0.39	0.37
1781	34.72	49.50	3.20	0.16	0.50	0.39	0.35
1786	35.93	51.00	3.21	0.18	0.51	0.40	0.36
1791	37.33	49.00	3.21	0.21	0.49	0.40	0.36
1796	36.76	52.00	3.22	0.20	0.52	0.40	0.37
1801	35.89	56.50	3.22	0.18	0.57	0.40	0.38
1806	38.70	51.00	3.24	0.23	0.51	0.41	0.38
1811	37.59	51.50	3.25	0.21	0.52	0.41	0.38
1816	37.86	52.50	3.26	0.21	0.53	0.42	0.39
1821	39.24	54.00	3.27	0.24	0.54	0.42	0.40
1826	39.92	57.00	3.28	0.25	0.57	0.43	0.41
1831	40.80	58.00	3.30	0.26	0.58	0.44	0.43
1836	40.15	57.00	3.33	0.25	0.57	0.45	0.42
1841	40.28	59.20	3.32	0.25	0.59	0.44	0.43
1846	39.56	59.60	3.38	0.24	0.60	0.47	0.44
1851	39.54	61.90	3.41	0.24	0.62	0.48	0.45
1856	40.39	65.50	3.45	0.26	0.66	0.50	0.47
1861	41.19	70.30	3.48	0.27	0.70	0.51	0.50
1866	40.32	74.20	3.52	0.26	0.74	0.53	0.51
1871	41.31	76.90	3.56	0.27	0.77	0.55	0.53
1871–80	43.00	80.38	3.57	0.30	0.80	0.55	0.55
1881–90	45.50	88.49	3.60	0.34	0.88	0.56	0.60
1891–1900	46.00	95.52	3.64	0.35	0.96	0.58	0.63
1901–10	50.50	98.20	3.68	0.43	0.98	0.60	0.67
1910–12	53.50	98.92	3.69	0.48	0.99	0.60	0.69
1920–22	57.60	100.00	3.65	0.54	1.00	0.59	0.71
1930–32	60.80	100.00	3.70	0.60	1.00	0.61	0.73
1950–52	69.00	100.00	3.85	0.73	1.00	0.67	0.80
1960–62	71.10	100.00	3.95	0.77	1.00	0.72	0.83
1970–72	72.20	100.00	4.07	0.79	1.00	0.77	0.85
1978–80	73.50	100.00	4.13	0.81	1.00	0.79	0.87

Sources: Expectation of life at birth (E_0): 1756–1871, Wrigley and Schofield (1981, table A3.1); 1871–80 to 1978–80, Office of Population Censuses and Surveys (1987, table 22). Adult literacy: 1756–1838, Schofield (1973); 1839, *Second Annual Report of the Registrar-General of Birth, Deaths and Marriages in England* (PP 1840 [263] xvii: 13); 1840, *Third Annual Report of the Registrar-General of Birth, Deaths and Marriages in England* (PP 1841 [11] [345] vi: 15); 1841–64, *Forty-fifth Annual Report of the Registrar-General of Birth, Deaths and Marriages in England* (PP 1884 C. 4009 xx: table 7); 1865–1914, *Seventy-seventh Annual Report of the Registrar-General of Birth, Deaths and Marriages in England and Wales* (PP 1916 Cd. 8206 v: table 10). GDP: 1756–1829, Crafts (1985a, 45); 1830–1980, Mitchell (1988, 531–41). U.K. population: 1756–1800, Wrigley and Schofield (1981, table A3.3); 1801–1980, Mitchell (1988, 11–44).

Notes: Expectation of life at birth (E_0): data for 1756–1871 are for England only (excluding Mon-

Table 3.7 (continued)

mouth); data for 1871–80 to 1978–80 cover the whole of England and Wales. Adult literacy: data for 1756–1838 are for 274 English parishes; data for 1839–1914 cover the whole of England and Wales. GDP per capita: Mitchell (1988, 531–41) provided estimates of U.K. GDP at market prices for 1830–1980. These figures were extrapolated backward using Crafts's (1985a, 45) estimates for the growth of Britain's GNP between 1701 and 1831. Mitchell's data were standardized at 1980 prices and then converted into 1990 prices using the price index in Central Statistical Office (1995b, 20–21). The revised data were converted into U.S. dollars using the exchange rate in Central Statistical Office (1995a, T62). Wrigley and Schofield (1981, table A3.3) provided estimates of English population totals for 1756–1801, and Mitchell (1988, 11–14) provided estimates for the whole of the United Kingdom from 1801 onward. The ratio of Mitchell's 1801 figures to Wrigley and Schofield's 1801 figures was used to convert Wrigley and Schofield's earlier estimates into figures for the United Kingdom as a whole.

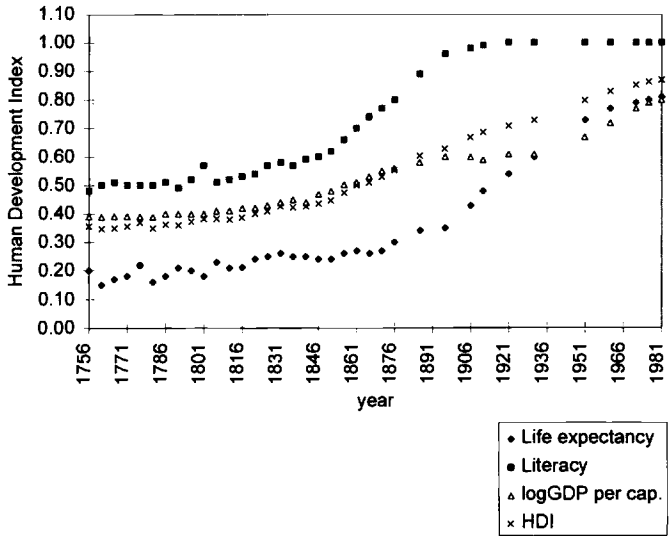

Fig. 3.8 Human development index (England and Wales/United Kingdom), 1756–1981

Source: See table 3.7.

increased from the early 1870s, and the literacy variable reached its maximum possible value on the eve of the First World War. The GDP variable remained relatively static during the second quarter of the twentieth century and only resumed its upward path after the end of the Second World War.

If we concentrate on the value of the index as a whole, a number of points stand out. In the first place, there is little evidence of any decline in the level of human welfare during the second half of the eighteenth century. The figures appear to show a very slow rate of improvement, which is broadly consistent with our interpretation of the changes in human height over the same period. The increase in the level of human development accelerated at the end of the

Napoleonic Wars, but there is some evidence of a decline in the rate of progress during the 1830s and early 1840s. The decline is less marked than the apparent decline in the average value of soldiers' heights, but it provides further evidence in support of the view that improvements in human welfare were arrested during the second quarter of the nineteenth century. The index reinforces the view that there has been a dramatic improvement in the standard of human welfare since the 1850s. The rate of improvement in the twentieth century is particularly remarkable, given the overall stability of the literacy indicator, and shows the overwhelming importance of increases in life expectancy.

3.6 Conclusions

This paper has had two main aims. Its first was to summarize the existing evidence of changes in the average height of the British population since the mid-eighteenth century. We believe that the history of human height in this period can be divided into three broad phases. During the first phase, which lasted from the middle of the eighteenth century to the end of the first quarter of the nineteenth century, the average height of British men increased very slowly, but there was a decline in the average heights of men born during the second quarter of the nineteenth century, followed by a sustained increase in average heights from the 1850s onward. We have also presented the results of some additional research into the heights of schoolchildren during the twentieth century. This research shows that the average height of British schoolchildren increased throughout the present century, but that there were still significant disparities in the heights of children from different social backgrounds at the end of the 1960s. Height continues to provide a powerful index of social and economic disadvantage.[4]

The second aim of the paper was to develop a modified version of the UN Human Development Index for use in historical analysis. We have shown that the average standard of "human development" increased very slowly during the second half of the eighteenth century, and that there is some evidence of an increase in the rate of progress during the early part of the nineteenth century. The rate of progress slowed down during the 1830s and early 1840s, and may even have been reversed, but the graph of human development resumed its upward path from the 1850s onward. It is important to recognize that the principles that underlie the calculation of the human development index are still under dispute, and that many of the figures that have been included in our calculations are subject to a wide margin of error. However, it is reassuring to note that there is a broad similarity between the results that have emerged from our analysis of the human development index and from our investigations into the history of human height during the course of this period.

4. For studies of the height of the British population since the 1960s, see Goldstein (1971), Rona, Swan, and Altman (1978), Knight and Eldridge (1984), and Gregory et al. (1990).

Appendix

Table 3A.1 **Average Age, Height, and Height in Centiles of Children in Leeds, 1909–46**

	Boys				Girls			
Year	Estimated Age	Number	Height (inches)	Centile (1965 = 50)	Estimated Age	Number	Height (inches)	Centile (1965 = 50)
1909	5.50	1,922	40.20	2.82	5.50	1,916	39.90	3.44
1910	5.25	1,618	39.80	4.09	5.25	1,618	39.40	4.31
1911	5.25	1,650	39.50	2.92	5.25	1,685	39.30	3.36
1912	5.50	2,441	40.00	2.22	5.50	2,414	39.60	2.42
1913	5.50	2,540	40.20	2.82	5.50	2,576	39.80	3.07
1914	5.50	2,116	40.00	2.22	5.50	2,181	39.90	3.44
1915	5.50	2,764	40.30	3.18	5.50	2,621	40.10	4.30
1916	5.50	2,745	40.20	2.82	5.50	2,720	40.30	5.33
1917	5.50	2,070	40.50	3.98	5.25	1,990	39.60	5.32
1918	5.50	1,443	40.40	3.56	5.50	1,319	40.10	4.30
1919	5.75	2,200	40.80	3.56	5.50	2,099	40.10	4.30
1920	5.50	2,872	40.60	4.45	5.50	2,953	40.20	4.80
1921	5.50	2,361	40.70	4.95	5.50	2,194	40.30	5.33
1922	5.50	1,784	41.00	6.75	5.50	1,922	40.60	7.23
1923	5.50	1,747	40.80	5.50	5.50	1,767	40.50	6.55
1924	5.50	1,747	40.80	5.50	5.50	1,776	40.60	7.23
1925	5.50	2,695	41.00	6.75	5.50	2,697	40.70	7.97
1926	5.50	2,263	41.20	8.20	5.50	2,347	40.90	9.61
1927	5.50	2,074	41.40	9.88	5.50	2,146	41.10	11.49
1928	5.50	1,896	41.40	9.88	5.50	1,915	41.00	10.52
1929	5.50	1,649	41.60	11.79	5.50	1,669	41.20	12.52
1930	5.50	1,647	41.60	11.79	5.50	1,682	41.40	14.77
1931	5.50	1,440	41.80	13.95	5.50	1,539	41.40	14.77
1932	5.50	1,599	41.60	11.79	5.50	1,553	41.40	14.77
1933	5.50	1,376	41.70	12.84	5.50	1,478	41.50	15.99
1934	5.50	1,392	41.80	13.95	5.50	1,393	41.40	14.77
1935	5.50	1,445	41.80	13.95	5.50	1,515	41.50	15.99
1936	5.50	1,365	41.90	15.13	5.50	1,394	41.50	15.99
1937	5.50	1,479	42.00	16.37	5.50	1,403	41.80	20.04
1938	5.50	1,290	42.40	21.97	5.50	1,309	41.70	18.63
1939	5.50	833	42.10	17.67	5.50	816	41.60	17.28
1940	5.50	1,010	42.60	25.14	5.50	871	42.00	23.05
1941	5.50	1,839	42.40	21.97	5.50	1,711	42.10	24.65
1942	5.50	2,264	42.30	20.48	5.50	2,145	42.00	23.05
1943	5.50	1,942	42.20	19.04	5.50	1,922	41.60	17.28
1944	5.50	1,324	42.30	20.48	5.50	1,450	41.90	21.52
1945	5.50	1,479	42.30	20.40	5.50	1,476	42.20	26.30
1946	5.50	1,888	42.30	20.48	5.50	1,781	42.20	26.30

Source: Harris (1989, 234–37).

Table 3A.2 **Average Age, Height, and Height in Centiles of Children in Glasgow, 1920–49**

	Boys				Girls			
Year	Estimated Age	Number	Height (inches)	Centile (1965 = 50)	Estimated Age	Number	Height (inches)	Centile (1965 = 50)
1920	5.50	7,296	40.90	6.10	5.75	6,932	40.70	5.25
1921	5.25	7,849	40.20	6.21	5.25	7,800	39.80	6.52
1922	5.50	7,845	40.50	3.98	5.50	7,550	40.10	4.30
1923	5.25	6,910	40.20	6.21	5.25	6,666	39.60	5.32
1924	5.50	5,899	40.70	4.95	5.50	5,892	40.30	5.33
1925	5.75	8,586	41.30	5.97	5.25	8,350	39.90	7.19
1926	5.42	10,209	40.80	7.29	5.42	10,250	40.30	7.02
1927	5.42	9,718	40.90	8.02	5.42	9,635	40.70	10.68
1928	5.42	10,331	40.60	6.00	5.42	10,086	40.30	7.02
1929	5.42	9,494	40.60	6.00	5.42	9,461	40.40	7.24
1930	5.33	9,133	41.00	10.84	5.33	9,059	40.80	13.41
1931	5.33	9,371	40.90	9.94	5.33	9,257	40.70	12.25
1932	5.33	8,827	41.10	9.63	5.33	8,661	40.70	12.25
1933	5.33	8,147	41.10	9.63	5.33	8,055	40.80	13.41
1934	5.33	9,060	41.20	11.82	5.33	8,811	40.90	14.52
1935	5.33	8,536	41.40	15.04	5.33	8,217	41.10	15.68
1936	5.33	8,793	41.40	15.04	5.33	8,921	41.10	15.68
1937	5.33	8,468	41.40	15.04	5.33	8,257	41.10	15.68
1938	5.33	8,375	41.70	18.81	5.33	8,181	41.40	20.99
1939	5.42	9,252	41.70	15.83	5.42	9,170	41.50	19.23
1940	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1941	5.50	7,697	42.16	18.49	5.50	7,615	41.84	20.62
1942	5.42	8,158	41.99	19.62	5.42	8,031	41.62	20.92
1943	5.33	8,284	41.91	21.77	5.33	7,936	41.49	22.32
1944	5.33	7,961	41.82	20.47	5.33	8,046	41.45	21.72
1945	5.33	8,260	41.95	22.36	5.33	8,072	41.62	20.92
1946	5.33	8,024	42.05	23.88	5.42	8,115	41.70	22.10
1947	5.33	7,496	41.93	22.06	5.33	7,218	41.58	23.68
1948	5.25	7,592	42.10	28.16	5.33	7,451	41.69	25.41
1949	5.33	8,601	42.39	29.44	5.50	8,036	42.02	30.79

Source: Harris (1989, 228–31).

Table 3A.3 U.K. GDP per Capita (in 1990 U.S. dollars), 1756 to 1978–80

Year	GDP per Capita (1990 U.S. $)	Year	GDP per Capita (1990 U.S. $)
1756	1,544.28	1846	2,405.27
1761	1,558.55	1851	2,574.45
1766	1,580.39	1856	2,839.43
1771	1,593.15	1861	3,025.17
1776	1,578.10	1866	3,285.38
1781	1,573.71	1871	3,666.11
1786	1,623.44	1871–80	3,702.37
1791	1,632.48	1881–90	3,957.18
1796	1,645.61	1891–1900	4,354.28
1801	1,662.61	1901–10	4,777.70
1806	1,719.43	1910–12	4,875.51
1811	1,775.17	1920–22	4,488.87
1816	1,814.88	1930–32	5,016.94
1821	1,859.11	1950–52	7,044.67
1826	1,907.24	1960–62	8,979.07
1831	2,015.02	1970–72	11,877.80
1836	2,136.43	1978–80	13,470.45
1841	2,077.15		

Sources: See table 3.7.

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