Volume Title: Health and Welfare during Industrialization

Volume Author/Editor: Richard H. Steckel and Roderick Floud, Eds.

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-77156-3

Volume URL: http://www.nber.org/books/stec97-1

Publication Date: January 1997

Chapter Title: Heights and Living Standards in Germany, 1850-1939: The Case of Wurttemberg

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Chapter URL: http://www.nber.org/chapters/c7434

Chapter pages in book: (p. 285 - 330)

8 Heights and Living Standards in Germany, 1850–1939: The Case of Württemberg

Sophia Twarog

8.1 Introduction

There is little doubt that, in the long run, industrialization generally benefits the population in the country in which it takes place. Yet, in the short run, optimist-pessimist debates concerning the social costs and benefits of industrialization exist for many countries. Optimists applaud rapidly rising per capita income and industrial output. Pessimists speak of rising income inequality and dismal living conditions of the urban working class.

In Germany, the optimist-pessimist debate usually focuses on the 1870s and 1880s—the beginning of the rapid industrialization period (1871–1914). Between 1871 and 1890, real per capita Net National Product (NNP) in 1913 prices rose at an average annual rate of 1.5 percent (calculated from table 8.3, below). Yet income inequality was rising (Dumke 1988), and there were other signs that all was not well with the German working class. According to Henderson (1975), "The poor-law authorities, the churches, and various charitable organizations were fighting an uphill battle against the effects of low wages, long hours, unemployment, sickness, and bad housing conditions." This distress prompted Bismarck to lay down the foundations of a social safety net. Several important pieces of social legislation were passed in the 1880s, including compulsory health and accident insurance for factory workers and others, as well as old age and disability pensions. Germany was the first large industrialized country to take such steps. It is possible that these measures helped

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The opinions expressed in this paper are those of the author and do not necessarily reflect the views of UNCTAD. The designations and terminology employed are also those of the author.

This contribution is largely based on the author's dissertation, "Heights and Living Standards in Industrializing Germany: The Case of Württemberg," which was completed in 1993 at Ohio State University under the direction of Richard Steckel.

ameliorate some of the hardships that often seem to go hand-in-hand with industrialization's onset. After the 1880s, particularly after 1885, German living standards were generally improving.

The goal of this paper is to examine the changes in the health and well-being of the German population during and after industrialization. The strategy employed is to marshall evidence on a wide range of indicators of living standards in Germany. Special attention is given to average population height, which, as a measure of net nutrition, is of particular value. Other indicators include real per capita income, gross wages, infant mortality, mortality, life expectancy, emigration, working hours in industry, and Hoffmann's index of caloric balance. Finally, an attempt is made to construct for historical Germany a Human Development Index (HDI), which is a composite measure of longevity, knowledge, and command over resources (i.e., income).

In this paper, special attention is given to the kingdom of Württemberg. There are two main reasons for this. First, regional variations during German industrialization were so large that relying solely on national averages can distort the underlying processes. Württemberg can be considered as representative of the relatively late industrializing German regions. Second, trends in average population heights are a particularly valuable indicator of physical living standards. To the best of the author's knowledge, the only continuous data available on height trends in Germany during the second half of the nineteenth century are for Württemberg. The main goal of this study, however, is to depict changes in living standards in Germany as a whole. Thus, wherever possible, data on the various indicators will be presented for both Württemberg and for Germany.

This paper begins with a brief discussion of industrialization in Württemberg and how this region fit into the larger German context. Section 8.3 examines trends in a range of indicators of living standards in Germany and in Württemberg. Section 8.4 highlights the main findings of the study.

8.2 Industrialization in Germany and Württemberg

Germany's industrialization has been referred to as "the most remarkable economic achievement of the nineteenth century" (Dillard 1967). The most rapid period of industrialization (*Hochindustrialisierung*) took place between 1871 and 1914. But considerable progress was made prior to this. In the mid-1830s, the establishment of the German Customs Union (*Zoll Verein*) and the opening of the first railway line in German territory ushered in what has been called the "dawn of the industrial era," 1834–51 (Henderson 1975). After 1851, economic development accelerated. Real per capita NNP (in 1913 prices) rose from DM 312 in 1850, to DM 424 in 1871, and further to DM 783 in 1913 (calculated from Hoffman 1965; see table 8.3). This implies growth rates in real per capita income of 14.6 percent per decade! The percentage of the German labor force employed in agriculture dropped from 54.6 percent in 1849–

Table 8.1 **Commercial Sector Employment as a Percentage of the Population (*Gewerbesatz*) in Several German Regions, 1875–1939**

State or Province	1875	1882	1895	1907	1925	1933	1939
Saxony	22.91	26.33	30.38	34.25	42.95	28.91	44.76
Württemberg	15.31	14.72	18.86	22.08	31	26.86	38.38
Rhineprovince	19	20.57	22.97	26.25	32.85	23.28	35.62
Baden	15.82	15.51	20.94	25.42	30.22	23.02	34.95
Westphalia	18.5	18.37	21.24	24.43	31.66	22.14	33.8
German Empire	15.14	16.23	19.64	23.14	30.04	22.35	33.39
Prussia	14.09	15.43	18.45	21.81	29.11	21.29	32.47
Bavaria	14.09	13.01	17.25	20.38	25.08	20.89	31.57
Hesse	15.2	15.05	19.33	21.56	27.36	21.05	31.24

Source: Megerle (1982).

55, to 35.1 percent in 1910–13, and further to 21.6 percent in 1950–54 (Hoffmann 1965). Meanwhile, the index of industrial production rose from 9.5 in 1850, to 21 in 1871, and to 100 in 1913—an average growth rate of 37.4 percent per decade between 1850 and 1913. This rate far surpasses that of neighboring France (17.4 percent per decade) and the United Kingdom (20.2 percent per decade) during the same period.[1] In less than a century, Germany made the transition from a predominantly agrarian society to an industrial giant.[2]

What was Württemberg's place in this historic event? One could argue that Württemberg's industrialization was reasonably representative of the "average" German industrialization experience. In support of this statement, consider table 8.1 showing commercial sector employment as a percentage of the population (*Gewerbesatz*) in several German regions between 1875 and 1939.[3] Through 1925, the figures for Württemberg were always within 1.5 percentage points of the German Empire average, and the employment trends in Württemberg and the German Empire ran fairly parallel courses.

In reality, however, regional variations in industrialization were so large in Germany that no single region could be truly representative. The unification under the umbrella of the German Empire in 1871 took place relatively late. Thereafter, individual states still had a great deal of autonomy in most areas outside of trade, currency, and military duty. Differences in state industrial policies and in natural resource endowments contributed to the regional differences in German economic development.

Kiesewetter (1986) divided German regional industrialization processes into three categories. The first group included areas such as Saxony and the Ruhr, which industrialized relatively early with emphasis on heavy industry such as

1. These figures were calculated from Mitchell (1980).

2. Numerous books and articles have been written on German industrialization. See, e.g., Hoffmann (1965), Kiesewetter (1989), Stolper (1940), and Henderson (1975).

3. "Commercial sector" refers to traditional craftsmen, manufacturing, businessmen, etc. Expressed as a percentage of the labor force, the figures would be much higher, of course.

iron, coal, and capital equipment. The second group included Württemberg, Baden, and Hesse. The lack of large deposits of coal and iron ore in these areas delayed rapid industrialization until the late nineteenth century and led to a focus on light industry. The third group was further subdivided into two subcategories: In the deindustrializing areas (such as the Harz and the Erzgebirge), it was increasingly difficult for the traditional ironworks to compete with the huge factories in the Ruhr and elsewhere. In the agricultural regions such as Posen and lower Bavaria, industrialization was very slow.

Württemberg would be considered representative of the second category of German industrialization processes. Yet even here, there were certain factors such as agricultural structure, natural resource endowment, industrial policy, railway expansion, and population development that made its industrialization experience unique. For example, Württemberg was a land of small landholders, where many farmers were also craftsmen or worked in factories. The ties to the land prevented the formation of a "landless proletariat" and at the same time gave commercial sector employees a safety net. These ties to the land also led to the decentralized industrial structure still apparent today. Since Württemberg had no coal, it specialized in light industry—such as finished metal goods, textiles, instruments, and optics.

In a nutshell, Württemberg's economic development between 1852 and 1940 can be described as follows: A severe agricultural crisis began in 1846–47. The bad situation lasted until 1854–55. The following years were characterized by considerable growth in the commercial sector, particularly between 1852 and 1861. Growth then slowed, decreasing Württemberg's industrial position relative to other states. In the 1870s and 1880s, Württemberg was finally connected by rail to the rest of the German Empire. The large influx of cheap grain caused agricultural prices to fall dramatically, eroding the importance of the second job in agriculture. The increased willingness to work full time in factories opened the door to rapid industrialization after 1882 and especially after 1895. Although the two world wars and the Great Depression did not spare this region, Württemberg proved relatively resilient. Today it is one of the most industrial and richest parts of Germany.

Urbanization accompanied industrialization in both Germany as a whole and in Württemberg. Table 8.2 shows the percentage of the German population living in seven categories of community size between 1852 and 1961. The trends are clear: The percentage of the population living in communities of less than 2,000 residents fell from 67.3 percent in 1852 to 23.2 percent in 1961. Meanwhile, the percentage living in cities with over 100,000 residents rose from 2.6 percent in 1852 to 31.1 percent in 1961. In Württemberg between 1834 and 1910, although the number of people in communities with less than 5,000 residents was fairly stable over the period, it steadily declined as a percentage of Württemberg's growing population (from 86.2 percent in 1834 to 64.2 percent in 1910). Between 1871 and 1910, the percentage of the popula-

Table 8.2 **Percentage of German Population in Community Size Classes, 1852–1961**

Community Size Class (number of residents)	1852	1871	1880	1890	1900	1910	1925	1933	1939	1950	1961
Under 2,000	67.3	63.9	59.2	53.0	46.2	40.0	35.6	32.9	30.1	28.9	23.2
2,000–5,000	13.1	12.4	11.9	19.1	11.5	11.3	10.8	10.6	10.7	13.6	12.4
5,000–10,000	6.2	6.3	6.6	19.1	7.1	7.6	6.9	7.1	7.5	8.9	9.1
10,000–20,000	4.8	4.9	5.4	6.0	6.3	6.5	6.2	6.0	6.4	7.1	7.4
20,000–50,000	3.5	3.6	4.8	6.9	7.3	7.9	8.0	7.7	8.4	8.8	10.0
50,000–100,000	2.5	4.1	3.3	2.9	4.5	5.4	5.7	5.3	5.3	5.4	6.7
Over 100,000	2.6	4.8	8.8	12.1	17.1	21.3	26.8	30.4	31.6	27.3	31.1

Source: Hoffmann (1965).

tion living in communities of less than 2,000 residents fell from 68.9 percent to 49.8 percent. In contrast, the percentage of the population living in communities with over 20,000 residents more than tripled (from 6.4 percent in 1871 to 21.1 percent in 1910; Königliches Statistisches Landesamt 1913b).

It is clear that between 1850 and 1939 Germany made a major shift from a rural agricultural society to a more urban, industry-based economy. How did this momentous change affect the health and welfare of the average German? The following section addresses this question by presenting evidence on a wide range of living standard indicators.

8.3 Indicators of Living Standards in Germany and Württemberg

8.3.1 Real Per Capita Income and Real Gross Wages

Probably the most widely used indicator of living standards is real per capita income. Table 8.3 shows the development of real per capita NNP in 1913 prices for the period 1850–1950 in Germany.[4] The upward trend is unmistakable. Between 1850 and 1938, real per capita NNP nearly quadrupled! The average annual growth rate was 1.52 percent.

Between 1850 and 1873, real per capita NNP rose at an average annual rate of 1.84 percent. During the euphoric speculation boom in 1871–73, the average yearly rate was 5.78 percent. The financial crash came in May 1873, and numerous bankruptcies followed. This event ushered in the period often referred to as the great depression in Germany (1873–96), during which average annual growth rates of real per capita NNP dropped to 1.24 percent. Things started to pick up again after 1896, and particularly after the turn of the century. Between

4. I have not located a time series for real per capita income in the kingdom of Württemberg. Even if these data were available, standard income accounting would be somewhat inadequate since it is likely that home production accounted for much of the consumption of Württemberg's small landholders and craftsmen.

Table 8.3 Real German Per Capita NNP in 1913 Prices, 1850–1950

Year	NNP in 1913 Prices (million DM)	Average Population (thousands)	Real Per Capita NNP in 1913 Prices	Log Real Per Capita NNP
1850	10,534	33,746	312	2.49
1851	10,568	34,055	310	2.49
1852	11,121	34,290	324	2.51
1853	10,630	34,422	308	2.49
1854	10,961	34,531	317	2.50
1855	10,316	34,586	298	2.47
1856	11,553	34,715	333	2.52
1857	11,845	34,979	339	2.53
1858	12,053	35,278	342	2.53
1859	12,219	35,633	343	2.53
1860	13,604	36,049	377	2.58
1861	13,002	36,435	357	2.55
1862	13,731	36,788	373	2.57
1863	14,639	37,184	394	2.59
1864	14,667	37,602	390	2.59
1865	14,858	37,955	391	2.59
1866	15,106	38,193	396	2.60
1867	15,108	38,440	393	2.59
1868	16,621	38,637	430	2.63
1869	15,660	38,914	402	2.60
1870	16,706	39,231	426	2.63
1871	17,395	40,997	424	2.63
1872	19,133	41,230	464	2.67
1873	19,768	41,564	476	2.68
1874	21,316	42,004	507	2.70
1875	21,070	42,518	496	2.69
1876	20,890	43,059	485	2.69
1877	20,705	43,610	475	2.68
1878	21,803	44,129	494	2.69
1879	21,193	44,641	475	2.68
1880	19,874	45,095	441	2.64
1881	20,616	45,428	454	2.66
1882	20,444	45,719	447	2.65
1883	21,909	46,016	476	2.66
1884	22,712	46,396	490	2.69
1885	23,452	46,707	502	2.70
1886	24,142	47,134	512	2.71
1887	24,558	47,630	516	2.71
1888	25,840	48,168	536	2.73
1889	26,478	48,717	544	2.74
1890	27,754	49,241	564	2.75
1891	26,822	49,762	539	2.73
1892	28,390	50,266	565	2.75
1893	30,606	50,757	603	2.78

Table 8.3 (continued)

Year	NNP in 1913 Prices (million DM)	Average Population (thousands)	Real Per Capita NNP in 1913 Prices	Log Real Per Capita NNP
1894	30,190	51,339	588	2.77
1895	32,079	52,001	617	2.79
1896	33,377	52,753	633	2.80
1897	34,739	53,569	648	2.81
1898	36,813	54,406	677	2.83
1899	36,860	55,248	667	2.82
1900	36,466	56,046	651	2.81
1901	36,197	56,874	636	2.80
1902	36,918	57,767	639	2.80
1903	40,132	58,629	684	2.83
1904	42,263	59,475	711	2.85
1905	43,346	60,314	719	2.86
1906	44,299	61,153	724	2.86
1907	46,181	62,013	745	2.87
1908	46,410	62,863	738	2.87
1909	47,512	63,717	746	2.87
1910	47,457	64,568	735	2.87
1911	49,648	65,359	760	2.88
1912	51,914	66,149	785	2.89
1913	52,440	66,978	783	2.89
1925	46,897	62,410	751	2.88
1926	46,587	62,867	741	2.87
1927	53,108	63,253	840	2.92
1928	53,950	63,618	848	2.93
1929	51,694	63,958	808	2.91
1930	49,289	64,295	767	2.88
1931	43,913	64,631	679	2.83
1932	41,760	64,912	643	2.80
1933	47,375	65,225	726	2.86
1934	52,102	65,243	799	2.90
1935	58,658	66,871	877	2.94
1936	66,226	67,349	983	2.99
1937	73,167	67,831	1,079	3.03
1938	81,335	68,558	1,186	3.07
1950	44,904	47,060	954	2.98

Source: Hoffmann (1965)

Notes: The borders of Germany changed over the period in question. In this table, the data are for the following territories: 1850–70, German Empire, 1913 borders, without Alsace-Lorraine; 1871–1913, German Empire, 1913 borders, with Alsace-Lorraine; 1925–38, German Empire, 1935–37 borders (1925–34 without Saarland, which was French administered at this time); 1950, Federal Republic of Germany (without Saarland and Berlin).

Estimates of NNP in constant prices are incomplete through 1880 and 1936–38.

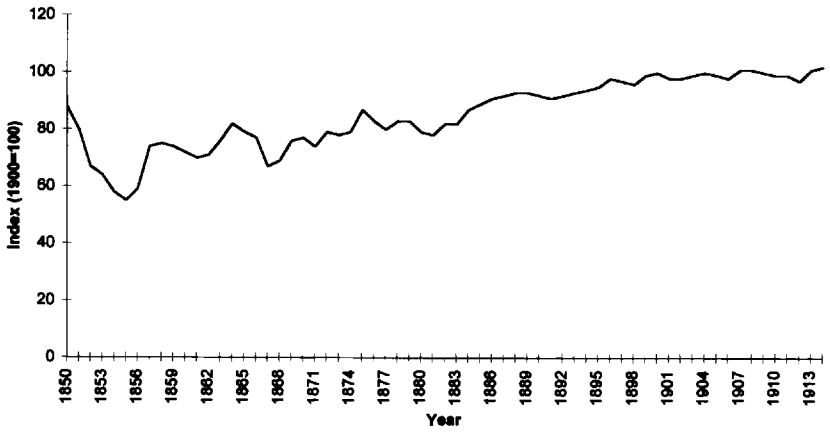

Fig. 8.1 Development of real gross wages in Germany, 1850–1914 (1900 = 100)
Source: Kuczynski (1947).

1900 and 1913, real per capita NNP increased at an average annual rate of 1.42 percent.

After 1913, the first available data in this time series are for 1925. Due to the First World War and the hyperinflation of 1921–23, real per capita NNP in 1913 prices fell from DM 783 in 1913 to DM 751 in 1925. The upswing that began in 1925 clipped along at an average annual rate of 1.83 percent until the Great Depression in 1929. Between 1929 and 1932, real per capita NNP fell from DM 808 to DM 643—an average annual decrease of 4.57 percent. After Hitler came to power in 1933, there was rapid economic recovery based on armaments and public works. Between 1934 and 1938, real per capita NNP rose from DM 799 to DM 1186—an average annual growth rate of 9.87 percent! After the Second World War, unlike most of its European neighbors, Germany had not yet attained its prewar real per capita income levels by 1950. This was due to heavy losses from fighting on German soil, low morale, reparations, monetary chaos through 1948, and military occupation. A rapid recovery began in 1949 and continued through the 1950s.

Figure 8.1 shows Kuczynski's index of real gross wages (1900 = 100) for German workers between 1850 and 1914. While the trend was generally positive, it was unevenly so, particularly before 1885. There was a large fall in real wages in the 1850s, and smaller ones in the late 1860s to early 1870s and in the early 1880s. These declines were largely driven by increases in the cost of living. Between 1885 and 1914, the cost of living continued to rise. However, nominal wages more than kept pace, leading to a steady gradual improvement in real gross wages. Also in Württemberg real wages were rising for many occupational categories during the second half of the nineteenth century (Losch 1898).

8.3.2 Average Population Heights

Württemberg Data and Methodology

When Germany was united in 1871, a universal draft law came into effect. All 20-year-old males were required to present themselves at the local recruiting depot to be measured and given a physical examination. For historical height studies, this is good news: there is no guesswork concerning the relationship between the observed population and the underlying population, as is the case with volunteer armies. The heights of all young German men were recorded. Unfortunately, the majority of these data were destroyed during World War II. To the best of my knowledge, only one data series has remained intact: the peacetime troop lists (*Friedenstammrollen*) of the army of Württemberg.

Luckily, this is a particularly rich source of information. Not only does it contain the soldier's height (recorded to the nearest half-centimeter), but also his occupation, often his father's occupation, his birthplace and birth date, his residence, his parents' residence, and his medical history during his term of duty. This enables some intriguing analysis of the covariates of historical heights.

Information was collected on approximately 15,000 soldiers serving between 1871 and 1913 (birth years 1851–93). Height trends were estimated using three statistical methods that correct for the lower tail erosion present in soldiers' height distribution due to minimum height and physical fitness standards. These methods are Reduced Sample Maximum Likelihood Estimation (RSMLE), which uses maximum likelihood estimation techniques on a truncated height distribution, Quantile Bend Estimation (QBE), which involves estimating the number of observations missing in the lower tail, and finally the simple mean of the reduced sample. Basic information on these methods and on the author's sampling procedure can be found in the appendix. For more detailed information, refer to Twarog (1993).

Height Trends in Württemberg for Birth Years 1852–93

Figure 8.2 shows QBE-estimated and unadjusted average heights, six-year moving averages, for the birth cohorts of 1852–57 to 1888–93. The QBE average height estimates for those born in the early 1850s were very low: the average stature for birth cohorts of 1852–57 was 164.1 cm.[5] When two-year moving averages were used, the QBE estimate for birth years 1852–53 was 161.2 cm. Average heights were rising for those born during this decade, reaching 167.4 cm for those born between 1856 and 1861. The early 1860s saw a short fall and recovery. A steeper fall in heights began with the late-1860s birth cohorts

5. When discussing historical height trends, it should be kept in mind that under suboptimal environmental conditions, growth can continue into the early 20s. It therefore seems likely that the height trends of 20-year-olds presented here slightly underestimate final adult male heights in Württemberg.

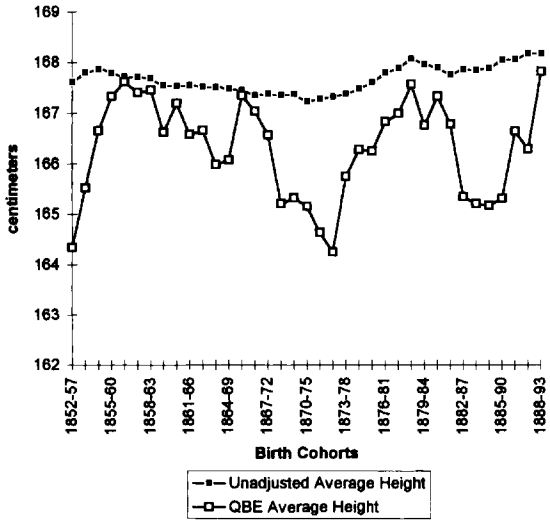

Fig. 8.2 Unadjusted and QBE average height estimates, six-year moving average, birth years 1852–57 to 1888–93
Source: Twarog (1993).

and reached its nadir in the mid-1870s (164 cm for birth years 1872–77). This was followed by a rise through the early 1880s (167.3 cm for those born between 1878 and 1883), a second dip in the late 1880s (nadir average height of 164.9 cm reached in birth years 1884–89), and an upward trend thereafter. The tallest six-year birth cohort was the last (1888–93), with a QBE-estimated average height of 167.6 cm.

For RSMLE, seven six-year phases were used. The reduced samples in each phase contained between 1,488 and 2,017 observations. Figure 8.3 shows the RSMLE average height estimates for the seven phases compared with the QBE estimates. Both methods indicated lowest stature in the earliest phase—birth years 1852–57. The RSMLE estimate of 163.1 cm was lower than the QBE estimate. Both estimators showed rising and then falling heights thereafter, with the RSMLE estimate reaching 165.2 cm for the birth cohorts of 1870–75. Then the stories diverged somewhat, with RSMLE showing steadily rising stature, and QBE showing the second dip in heights in the mid-1880s.

The results look much more similar, however, if one uses RSMLE truncated regression to estimate average height for two-year birth cohorts. Table 8.4 and figure 8.4 show that the RSMLE stature estimates were very low for those born in the early 1850s—160.56 for the 1852–53 cohort. Thereafter, they were rising. In the 1870s, there is a marked dip in heights, followed by a rise and then a second dip in the mid-1880s, followed by a recovery.

Figure 8.5 shows trends in the simple mean of the reduced sample using six-

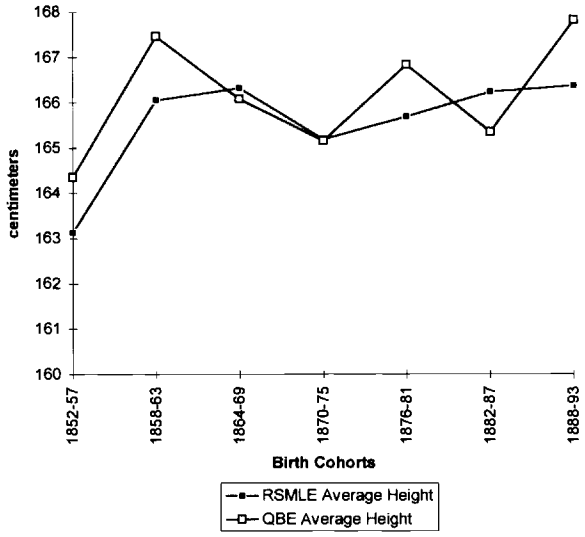

Fig. 8.3 RSMLE and QBE average height estimates, seven phases, birth years 1852–57 to 1888–93
Source: Twarog (1993).

year moving averages. One sees a similar pattern to that observed with the other methods, although the dip in heights in the 1870s was much shallower. However, if rising income inequality in the 1870s led to larger standard deviations in the population's height distribution, a small dip in the simple mean of the reduced sample would result from a steeper dip in the true average population height. Thus all three estimation methods yielded results that were reasonably consistent.

Interpreting average height trends in light of historical circumstances is complicated. The very feature that makes stature such a valuable indicator—that it is a net measure of a number of factors contributing to human well-being—also makes it hard to determine with absolute certainty what is driving a particular change in stature. This inherent difficulty is amplified by the lack of full historical information on all possible contributing factors (e.g., caloric and protein intake, illness, work effort, and breast-feeding practices). Moreover, since the use of stature in economic history is still fairly new, the exact equation mapping economic and environmental factors into average stature is still under study. Keeping these caveats in mind, one can still make educated guesses in light of the available information and continue to study the problem. This is what I have attempted to do for height trends in Württemberg.

Perhaps the most striking finding is that average heights were quite low in Württemberg throughout the second half of the nineteenth century. Average

Table 8.4 **RSMLE Average Height (AVHT) Estimates, Two-Year Birth Cohorts, Birth Years 1852–53 to 1892–93**

Phase	Coefficient	S.E.	*t*-Statistic	AVHT (cm)
Phase 1				
1852–53	160.56	1.196		160.56
1854–55	3.3892***	0.8749	3.874	163.95
1856–57	4.1063***	0.9199	4.464	164.67
Phase 2				
1858–59	165.87	0.5771		165.87
1860–61	0.0155	0.569	0.027	165.89
1862–63	0.5237	0.5693	0.092	166.39
Phase 3				
1864–65	165.89	0.5441		165.89
1866–67	0.7972	0.5475	1.456	166.69
1868–69	0.4578	0.5363	0.854	166.36
Phase 4				
1870–71	164.48	0.7042		164.48
1872–73	1.1975*	0.618	1.938	165.68
1874–75	0.90439	0.6334	1.428	165.38
Phase 5				
1876–77	164.86	0.6734		164.86
1878–79	0.8112	0.6171	1.315	165.67
1880–81	1.9174***	0.6184	3.101	166.78
Phase 6				
1882–83	166.85	0.5475		166.85
1884–85	−0.1928**	0.5918	−2.366	165.45
1886–87	−0.06263	0.5613	−1.116	166.22
Phase 7				
1888–89	166.24	0.5445		166.24
1890–91	−0.1928	0.5457	−0.353	166.05
1892–93	0.739	0.5369	1.376	166.98

Source: Twarog (1993).

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

stature never exceeded the 7th percentile of modern height standards.[6] The reasons for this included poor nutrition, hard work on family farms, poor health care (especially for children), and the practice of not breast-feeding infants.[7]

6. In the following discussion of height trends, the stature estimates referred to are RSMLE estimates for two-year birth cohorts. I prefer using the RSMLE results since they generally displayed less fluctuation than the QBE results, possibly due to the modest sample sizes.

The modern height percentiles used throughout this paper are those in Steckel (1996). They are based on data published by the National Center for Health Statistics (1977). These height standards are useful for most "Western" populations.

7. There was often a fatalistic attitude toward children's illnesses in Württemberg. Thus, many sick children died without ever having received medical attention (Königliches Statistisch-Topographisches Bureau 1875).

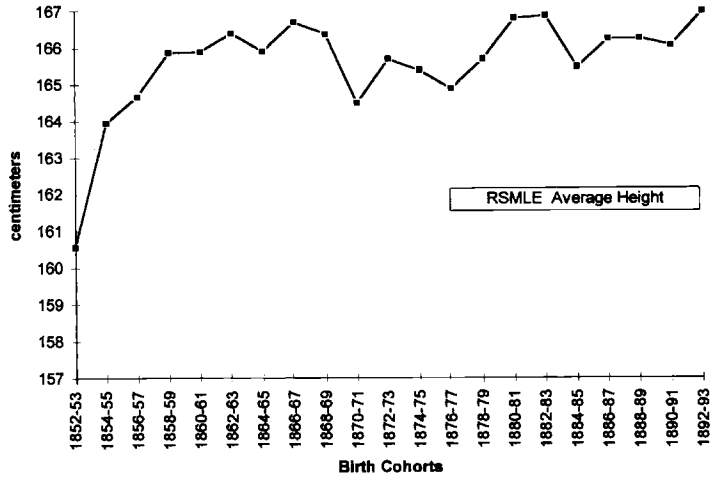

Fig. 8.4 RSMLE average height estimates, two-year birth cohorts, birth years 1852–53 to 1892–93
Source: Twarog (1993).

As will be discussed in section 8.3.3, these low average heights corresponded to extremely high infant mortality rates in Württemberg. As will be seen in section 8.3.5, the primary cause of death for infants was gastrointestinal illnesses. Even for those children who survived early childhood, it is likely that many of the nutrients they consumed were not absorbed properly into their bodies. Thus net nutrition—especially for children—was not very good throughout the period studied.

Some periods were, however, worse than others. Stature was extremely low for those born in the early 1850s. The RSMLE estimate of 160.56 cm for the birth cohorts of 1852 and 1853 was considerably below the first centile of modern height standards (161.7 cm). This corresponded to a time of severe agricultural crisis in Württemberg. Craftsmen who were farmers on the side shifted their labor into the handicraft sector. This, combined with decreased demand from the agricultural sector, caused the prices of manufactured goods to fall. Thus farmers and craftsmen were both hit hard by the crisis.

After the crisis ended, heights recovered unevenly, reaching the 6th percentile of modern height standards for birth years 1866–67. With the birth cohorts of the early 1870s, however, they plummeted once again, reaching the 3d modern height percentile. This height decline could be partially due to the Founder's Crisis. German unification in 1871 was followed by very high inflation in 1872 and 1873 and a speculation boom. The crash came in 1873. Industrial output, prices, and wages fell, while unemployment and bankruptcies rose.

Another factor that probably affected stature was the large surge in births owing in part to relaxed restrictions on marriage immediately following the

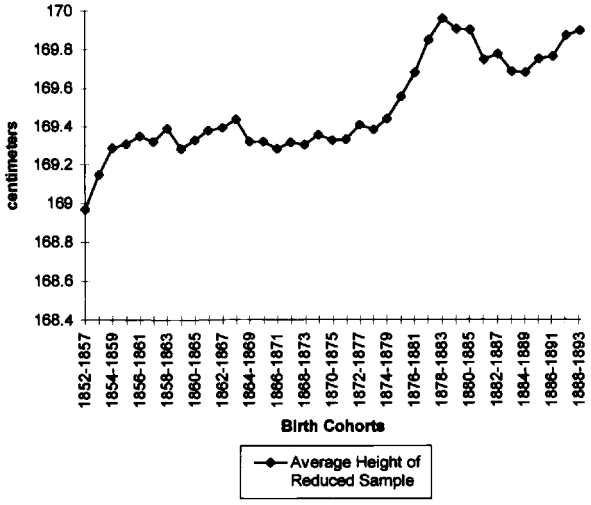

Fig. 8.5 Average height of reduced sample, six-year moving average, birth years 1852–57 to 1888–93
Source: Twarog (1993).

German unification. Birthrates between 1872 and 1877 ranged from 45.5 to 47.2 per 1,000 population—by far the highest levels of the century for Württemberg, which consistently had some of the highest birthrates in Europe (Königliches Statistisches Landesamt 1901). With so many children being born, it is probable that not all were cared for properly. In particular, such high birthrates could be reflecting lower breast-feeding rates, since breast-feeding acts as a natural contraceptive. The negative impact on infant health of not breast-feeding is discussed in the section on infant mortality. Other factors contributing to this dip in stature are under investigation.

In the 1870s and 1880s, Württemberg's railways were finally connected to the rest of Germany. Local industry and agriculture were suddenly confronted with an influx of cheaper grains and manufactured goods. Small farmers and traditional craftsmen suffered as their way of life was slowly being phased out.[8]

That the 1880s were rather difficult times is evidenced by the second dip in heights,[9] which coincided with a surge in emigration. There were stories of

8. While the changes brought on with Württemberg's rail connection initially led to some hardship for those forced to adapt, in the longer term the effect was beneficial. The railways could bring nutrients into Württemberg during local agricultural crises. They also eventually stimulated Württemberg's economy by providing an outlet for exportables. In fact, preliminary study indicates that toward the end of the period studied, stature was greater in those counties with railway connections (Twarog 1993).

9. Note that those belonging to the relatively short birth cohorts of the mid-1870s would have entered their adolescent growth spurt in the 1880s. Thus they were adversely affected during both of their rapid growth periods, which could help explain why the observed height dip of the 1870s was so deep.

social distress and increased numbers of people needing alms. These conditions in Germany prompted the passing of several important pieces of social legislation, including health and accident insurance laws. Perhaps these contributed to the upward trend in average heights seen after the mid-1880s. Certainly, rising incomes, better diet, improved public health, and possibly changes in breast-feeding practices also played a role. Between the birth cohorts of 1884–85 and 1892–93, average stature rose over 1.5 cm—from the 3d almost to the 7th percentile of modern height standards. This corresponded to a period of declining mortality and infant mortality rates in Württemberg and in Germany as a whole.

Occupational Differences

The Württemberg data always included the occupation of the soldier and often that of the soldier's father. This allowed analysis of height trends within occupation, a sample of which will be shown here. Occupations were classified into three broad categories: the upper class (consisting of white-collar workers), the working class (consisting of skilled, semiskilled, and unskilled workers), and those employed in agriculture.

Figures 8.6 and 8.7 show the QBE- and RSMLE-estimated height trends for these three occupational categories. The upper class was considerably taller than the agricultural class, which in turn was taller than the working class. The differentials between the upper and working classes widened considerably starting with the birth cohorts of the late 1860s, confirming Dumke's finding of increased income inequality during this period (Dumke 1988). The working

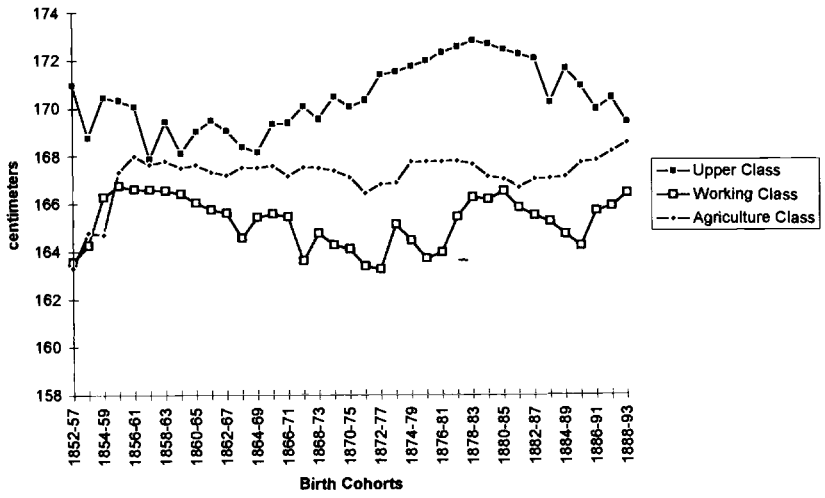

Fig. 8.6 QBE average height estimates by soldier's occupation, six-year moving average, birth years 1852–57 to 1888–93
Source: Twarog (1993).

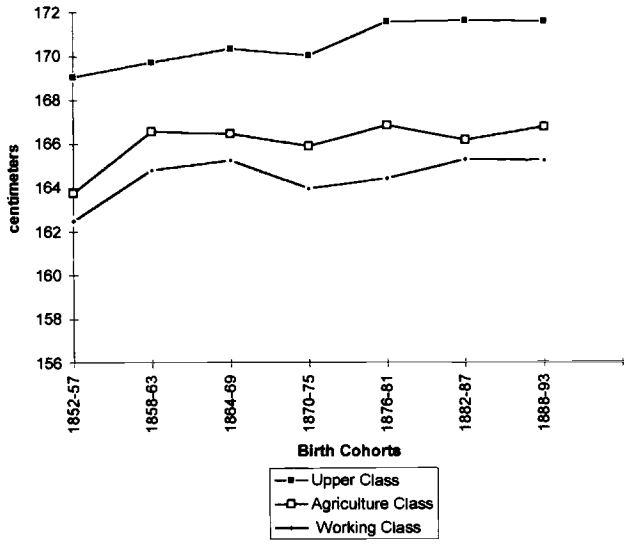

Fig. 8.7 RSMLE average height estimates by soldier's occupation, seven phases, birth years 1852–57 to 1888–93
Source: Twarog (1993).

Table 8.5 RSMLE Average Height Estimates (in centimeters) by Father's and Soldier's Occupation, Birth Years 1852–93

Father's Occupation	Soldier's Occupation		
	Upper	Working	*N* of R.S.[a]
Upper	170.42	165.53	1,129
Working	168.71	164.66	2,779

Source: Twarog (1993).
[a]*N* of R.S. refers to the number of observations in the reduced sample.

and agricultural classes were most severely hit by the agricultural crisis of the early 1850s. Those born into the working class appear to have seen a particular decline in their net nutrition in the 1870s.

Approximately half of the observations in the data set contained information on both the soldier's and the soldier's father's occupation. The analysis that this enabled indicated a clear positive correlation between stature and social mobility. Table 8.5 shows the results of running two RSMLE truncated regressions using the data subset where father and son were either upper or working class. Where the father and son were upper class, the average height was 170.42 cm. When, however, the father was upper class and the son was downwardly socially mobile (i.e., working class), the average height was 165.53 cm.

Table 8.6 **Unadjusted Average Height (AVHT) by Father's and Soldier's Occupational Category**

Father's Occupational Category	Soldier's Occupational Category																					
	1			2			3			4			5			6			7			
	N	%	AVHT	*N*	%	AVHT	*N*	%	AVHT	*N*	%	AVHT	*N*	%	AVHT	*N*	%	AVHT	*N*	%	AVHT	Total
1	286	50.8	172.68	90	16.0	170.13	24	4.3	168.46	2	0.4	167.5	0	0	–	151	26.8	171.29	10	1.8	168.5	563
2	73	28.7	172.42	82	32.3	170.53	34	13.4	169.90	8	3.1	167.44	1	0.4	164.5	38	15.0	171.26	18	7.1	168.33	254
3	44	1.7	171.58	67	2.6	170.41	1,735	68.0	166.49	285	11.2	165.99	52	2.0	166.37	83	3.3	168.12	284	11.1	166.05	2,550
4	3	0.4	167.5	25	3.5	167.22	298	42.3	165.74	228	32.3	166.82	16	2.3	167.53	15	2.1	170.90	120	17.0	166.29	705
5	0	0	–	2	0.4	171.00	182	36.8	165.94	91	18.4	166.00	35	7.1	166.06	1	0.2	168.50	184	37.2	165.57	495
6	58	15.2	170.80	40	10.5	169.88	58	15.2	166.78	25	6.5	165.04	5	1.3	168.00	176	46.1	169.72	20	5.2	167.63	382
7	40	1.5	171.71	31	1.2	169.95	613	23.1	166.14	208	7.8	166.62	34	1.3	167.49	27	1.0	170.54	1,699	64.1	167.69	2,652
Illegitimate	0	0	–	1	2.1	161.0	20	41.7	163.08	6	12.5	164.83	1	2.1	160.5	0	0	–	20	41.7	163.85	48

Source: Twarog (1993).

Notes: AVHT given in centimeters. The seven categories are (1) upper white collar, (2) lower white collar, (3) skilled, (4) semiskilled, (5) unskilled, (6) businessman, and (7) agriculture. There are also 48 illegitimately born soldiers whose father's occupation was not given.

Conversely, when both father and son were working class, the average height was 164.66 cm. When, however, the son was upwardly socially mobile, the average height was 168.71 cm. Both of these results were significant at the .000001 level.

Table 8.6 shows that similar patterns are observed if one divides occupations into seven categories. For example, where both the father's and son's occupations were upper white collar, the unadjusted average height was 172.68 cm. As the sons were increasingly downwardly socially mobile, the unadjusted average heights fell: 170.13 cm for lower white collar, 168.46 for skilled workers, and 167.5 for semiskilled workers.[10]

Urban-Rural Differences

In contrast to the findings in some other European countries, urbanization in Württemberg does not appear to be the main culprit in height declines seen during industrialization. In fact, as can be seen in figure 8.8, those born in urban areas (communities with over 2,000 residents) were significantly taller than those born in rural areas. This result remained significant even when occupational factors were included in the regression equation. This finding is likely due to relatively good public health infrastructure, regular inspections by public health authorities, higher incomes, and better medical attention in the cities. Moreover, urban dwellers probably listened more to government exhortations to breast-feed infants. The lower birthrates in the cities could be due to higher breast-feeding rates.[11]

It should be noted, however, that the cities in Württemberg were relatively small. Only Stuttgart had a population over 50,000 in the nineteenth century. In fact, when community size was further subdivided into six categories, one sees in figure 8.9 that the average height of those born in Stuttgart declined after the mid-1860s and was surpassed by those born in communities with 20,000–49,999 residents.[12] Thus it could be that urbanization's negative effects begin to show after a certain threshold is reached.

Heights in Württemberg for Birth Years before 1852

Information on stature before 1850 is limited.[13] Most published studies of military heights for the earlier period mention only the percentage of those called up that were under the minimum height or that were unfit for other reasons (Wurm 1990). There are, however, two studies that estimated the unadjusted average height of soldiers serving in Württemberg's army. In the first,

10. These differentials are probably underestimated since unadjusted average heights are used. However, the number of observations with information on father's occupation is too small to support accurate RSMLE estimates for all 49 occupational subsets.

11. More data and research on urban-rural breast-feeding practices are needed.

12. Community size classifications are based on population data for 1895.

13. John Komlos (University of Munich) has recorded height data contained in the *Musterungslisten* of the early nineteenth century in Württemberg. I look forward to the results of the data analysis.

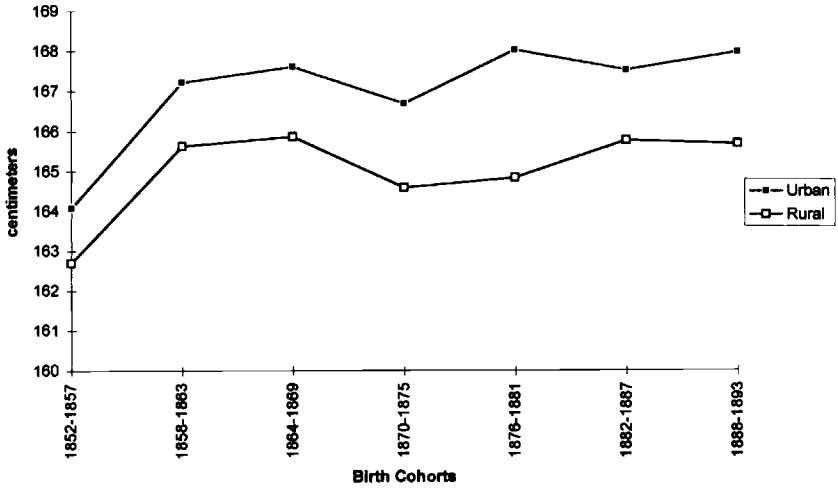

Fig. 8.8 RSMLE average height estimates for soldiers born in rural (less than 2,000 residents) and urban communities, seven phases, 1852–57 to 1888–93
Source: Twarog (1993).

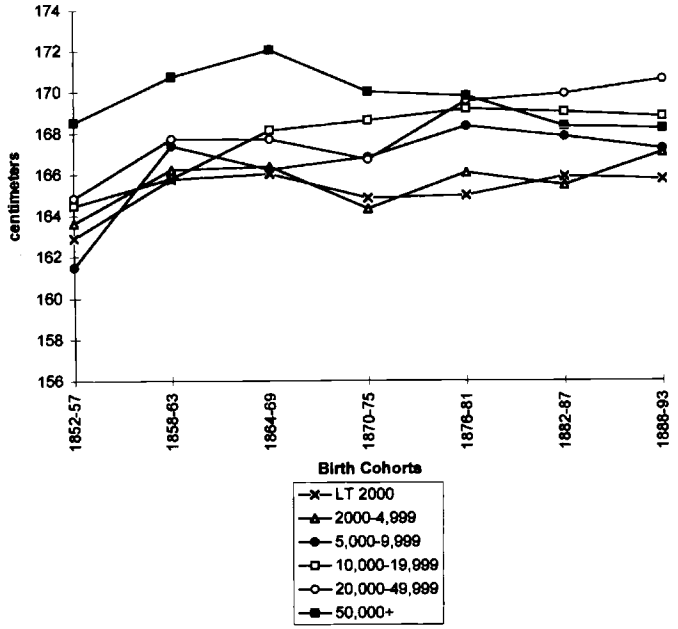

Fig. 8.9 RSMLE average height estimates by birth community size (in 1895), seven phases, birth years 1852–57 to 1888–93
Source: Twarog (1993).

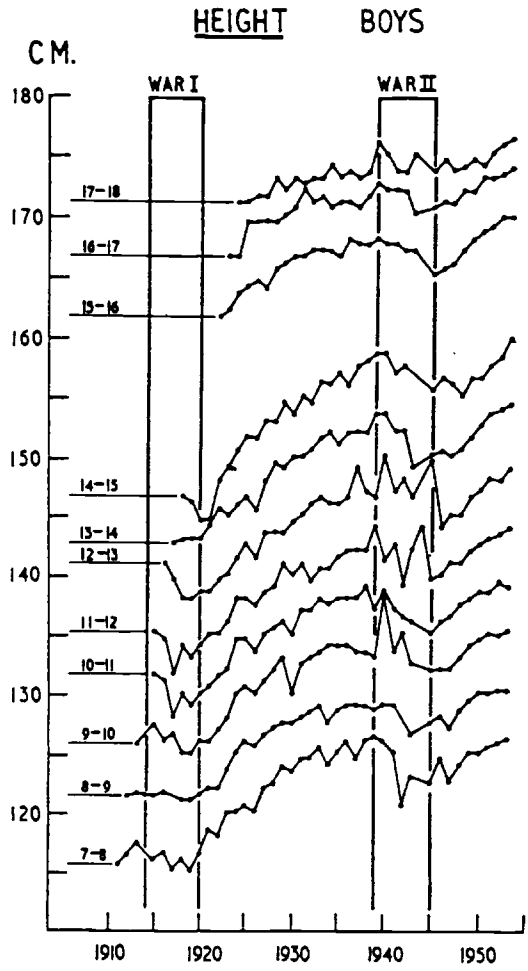

Fig. 8.10 Heights of Stuttgart schoolchildren, 1912–53
Sources: Tanner (1962), cited in Tanner (1978).

the soldiers' unadjusted average height for the years 1829–33 (mainly birth years 1809–13) was found to be 164.5 cm (Riedle 1834 in Wurm 1990). In the second, the unadjusted average height of soldiers in 1866 and 1867 (mainly birth years 1846–47) was calculated to be 166.1 cm (Retter 1869 in Wurm 1990). Both of these figures overestimate the true population mean since those who did not meet the minimum height or physical fitness standards were not included.[14] The figures do seem to indicate, however, that the net nutrition of

14. E.g., in 1866 and 1867, 10–11 percent of all those called up did not meet the minimum height requirement of 157.5 cm (Retter 1869 in Wurm 1990). For comparison purposes, in the author's sample of soldiers born in 1852 and 1853, the unadjusted average height was 166.8 cm; the QBE estimate was 161.2 cm, and the RSMLE estimate was 160.6 cm.

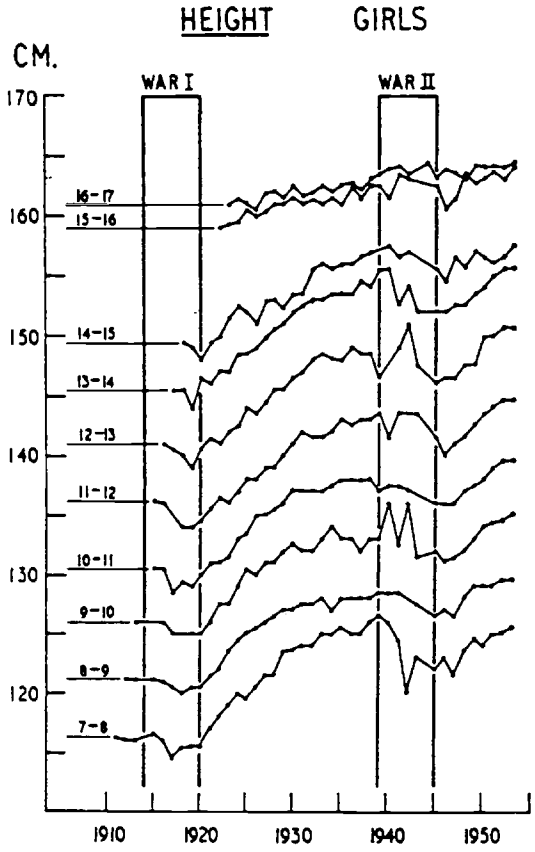

Fig. 8.10 (continued)

those born in Württemberg in the mid-1840s was better than that of those born 30 years earlier.

Heights in Württemberg for Birth Years after 1893

There are three pieces of evidence the author has thus far on height trends in Württemberg beyond 1893. One is figure 8.10—a graph of schoolchildren's heights in Stuttgart during the first half of the twentieth century.[15] In the mid-1920s, upper- and middle-class boys aged 17–18 years were approximately 171 cm tall. The average height of this group increased thereafter (except for declines during the World War II years) reaching approximately 175 cm by 1955.

15. The height data for children aged 15 and up are for children attending the *Oberschule* (upper school)—generally upper and middle-class children. The younger children were from the *Volksschule*, which all German children had to attend.

This represents an increase from approximately the 20th to the 40th percentile of modern height standards. During the same period, the stature of upper- and middle-class girls aged 16–17 increased from approximately 161 cm to 163 cm—from the 35th to the 50th percentile of modern standards for 17-year-olds. The height gains of children in age groups 7–8 through 14–15 (upper, middle, and lower classes together) during this period were even more dramatic—often more than 8 cm in 30 years. For example, the average stature of boys and girls aged 7–8 years increased 9–10 cm between 1911 and 1939—from approximately the 2d to the 30th percentile of modern height standards for 8-year-olds.[16] These figures clearly show that, despite setbacks during the war years, the net nutrition of children in Stuttgart increased substantially throughout the first half of the twentieth century.

Harbeck (1960) analyzed the heights of all 20-year-old German men called up and measured in 1957 (birth year 1937). The region of Baden-Württemberg (note, not just Württemberg) showed an average height of 171.8. This is more than 4.5 cm greater than the RSMLE estimate of average height for those born in 1892–93 (166.98 cm). It corresponds to a rise from approximately the 7th to the 22d percentile of modern height standards. Moreover, Jürgens (1971) found that the average stature of 1,142 draftable 20-year-olds born in Baden-Württemberg in 1948–49 was 176.8 cm. This equals the 50th percentile of modern height standards. These findings certainly strengthen the above evidence of an improvement in net nutrition in Württemberg during the first half of the twentieth century.

One other interesting fact emerges. For the birth cohorts of 1937, the average stature in Baden-Württemberg was 1.4 cm lower than the German average of 173.2 cm. This fits into the general pattern of historical heights in Germany, where stature decreased as one moved from north to south (Wurm 1982). For the birth cohorts of 1948–49, however, this pattern no longer held true. The average height in Baden-Württemberg was 0.5 cm greater than the German average of 176.3 (Jürgens 1971). Thus net nutrition of those born in Baden-Württemberg improved both absolutely and relative to the German average toward the middle of the twentieth century. It is likely that migration into Baden-Württemberg, increasing incomes and meat consumption, and possibly changes in infant feeding practices played a role in this outcome.

8.3.3 Infant Mortality Rates

Continuous data on infant mortality rates for all of Germany or for Württemberg in the nineteenth century are unavailable. There are, however, data for Prussia between 1816 and 1900. The average Prussian infant mortality rate was actually higher in the second half of the century than in the first half. Not until 1852 did more than 20 percent of Prussian infants die in the first year. Those

16. This is the equivalent of a shift from approximately the 10th to the 60th percentile of modern height standards for 7-year-olds.

born in the 1860s and 1870s had particularly high infant mortality rates (generally between 200 and 220 infant deaths per 1,000 births; Wiegand and Zapf 1982).

Infant mortality data are available for the territory of the German Empire (1881–1938) and the Federal Republic of Germany (after 1949). In the last two decades of the nineteenth century, between 230 and 280 infants died or were stillborn per 1,000 live births. After 1905, the trend was clearly downward, falling from 205/1,000 in 1905 to 105/1,000 in 1925—a nearly 50 percent drop in only 20 years. The fast decline continued through 1938, when the infant mortality rate reached 60/1,000. Thereafter, the rate of decrease slowed. Infant mortality rates finally went under 30/1,000 in 1963 and stayed there (Flora, Kraus, and Pfenning 1987).

For Württemberg, I have found data for some years between 1812 and 1897. Table 8.7 and figure 8.11 show these findings. One notices immediately that infant mortality rates in Württemberg were shockingly high—never falling below 200 per 1,000 live births, and even reaching 408/1,000 in 1865. The rates were generally rising through 1865. Data are missing for the years 1866–74. After 1875, the rates were clearly falling, albeit a bit unevenly. Württemberg had one of the highest infant mortality rates in Europe. For the period of the mid-1840s to mid-1850s, for example, Württemberg's rate was more than double that of Sweden, Denmark, Norway, Belgium, England, and France (Königliches Statistisch-Topographisches Bureau 1875). One reason for these high

Table 8.7 **Infant Mortality Rates per 1,000 Live Births in Württemberg, 1812–22 to 1897 (available years)**

Year	Infant Mortality	Year	Infant Mortality
1812–22	320.6	1882	273.2
1846–56	347.8	1883	275.4
1858–59	328	1884	291.8
1859–60	364	1885	276.1
1860–61	312	1886	282.6
1861–62	408	1887	234.9
1862–63	321	1888	254.4
1863–64	350	1889	265.1
1865	408	1890	246.1
1875	337.8	1891	256
1877	299	1892	256.3
1878	289	1893	249.8
1879	303	1896	207.7
1880	300.4	1897	248.8
1881	284.2		

Sources: Königliches Medizinal-Kollegium (1884, 1900), Königliches Statistisches Landesamt (1886, 1891, 1892, 1895, 1897), Königliches Statistisch-Topographisches Bureau (1875, 1877, 1878, 1880, 1885), and Württembergischer Ärztlicher Verein (1867).

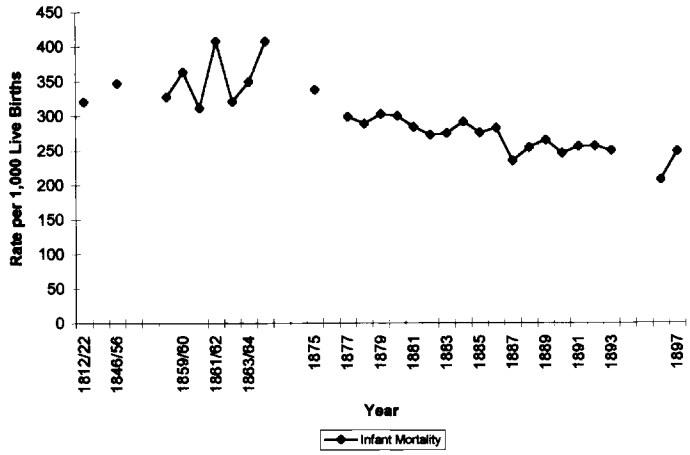

Fig. 8.11 Infant mortality rates per 1,000 live births in Württemberg, 1812–22 to 1897 (available years)
Source: Table 8.7.

infant mortality rates is that Württemberg was a land of small, relatively poor landowners. Farmers' wives generally had many children, were poorly nourished, and worked very hard in the house and the fields. Thus infants were often neglected and seldom received medical attention when ill.

An even more significant cause of the extreme infant mortality was the local custom of not breast-feeding infants.[17] Breast milk is beyond doubt the best food source for infants. It is designed especially for the human baby, with the ideal combination of proteins, carbohydrates, fats, vitamins, and so forth. Moreover, it contains antibodies that greatly increase an infant's resistance to infections. It is easily digestible and reduces the risk of food allergies. Breast-feeding significantly reduces infant morbidity and mortality rates (La Leche League International 1993).

In Württemberg, instead of breast milk, infants were often given an unsterilized mixture of flour and water.[18] Ironically, this custom was strongest in the Donaukreis, where landholdings tended to be larger and farmers' wives would have had the time and nourishment to tend their children properly.[19] Thus in

17. This lack of breast-feeding also contributed to Württemberg's exceptionally high birthrates, since breast-feeding is a natural contraceptive.

18. Wet-nursing was apparently not a widespread custom in Württemberg since I have found no mention of it in the course of my research.

19. How this local custom of not breast-feeding (*nicht stillen*) came about is still not obvious. It seems that land inheritance practices could have played a role. In the Donaukreis, all the land was generally inherited by the oldest surviving son. Thus, it was perhaps perceived to be less tragic if later sons died in infancy since they would have been second-class citizens in the agricultural hierarchy (Königliches Statistisch-Topographisches Bureau 1875).

Table 8.8 **Infant Mortality in Five Categories of Community Size in Württemberg, 1889–98 and 1899**

Community Size Category (number of residents)	Infants Who Died in First Year of Life			
	1889–98 Average		1899	
	Overall	Percentage of Live Births	Overall	Percentage of Live Births
Over 100,000	1,018	23.48	1,023	20.10
20,000–100,000	779	22.87	786	19.63
10,000–20,000	790	22.80	832	21.79
5,000–10,000	1,344	25.44	1,411	22.83
Under 5,000	13,481	25.07	11,885	21.72

Source: Königliches Statistisches Landesamt (1901).

1865, when 408 out of every 1,000 infants died in Württemberg, 470.4 out of every 1,000 born in the Donaukreis died in their first year. This is considerably higher than the rate in the poorest region (411 in Jaxtkreis) as well as the other two regions (383 in Schwarzwaldkreis and 381 in Neckarkreis; Württembergischer Ärztlicher Verein 1867).

Breast-feeding practices also appear to have a large impact on adult heights. The poor health conditions during the high-growth period of infancy can cause permanent stunting of heights if not followed by a period of excellent net nutrition—enough for catch-up growth. This could be a main reason for the relatively short stature in Württemberg during this period. Michael Haines (personal correspondence, 1993) examined this relationship in over 60 German regions in the early twentieth century. His findings clearly indicate that those areas with the highest percentage of infants breast-fed had the lowest infant mortality rates and the tallest young men. This correlation was seen in Württemberg as well: stature in the Donaukreis (discussed above) was lower than would be expected considering the relatively high incomes. This relationship needs to be studied further. Changes in women's work and breast-feeding practices linked with industrialization or urbanization could be a major avenue through which industrialization affects stature.

As table 8.8 shows, infant mortality rates in Württemberg tended to be lower in the cities. The above-mentioned two factors could be driving this result. Urban women did not have to work in the fields, and many could stay home to tend their less numerous offspring. Access to medical attention was much easier in the cities, and incomes tended to be higher. Furthermore, it is likely that urban women were more influenced by the health authorities' promotion of breast-feeding. The lower urban birthrates would support this proposition. The lower infant mortality rates correspond to the taller statures of those born in urban areas.

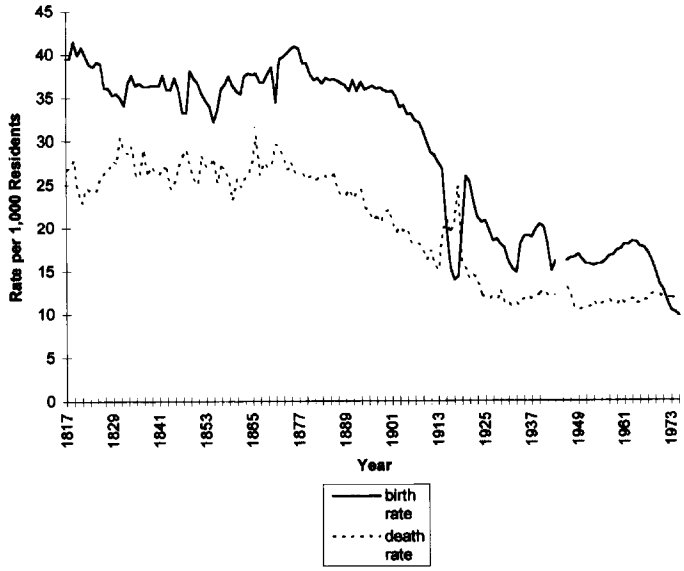

Fig. 8.12 Birth and death rates per 1,000 residents in Germany, 1817–1975
Source: Mitchell (1980).

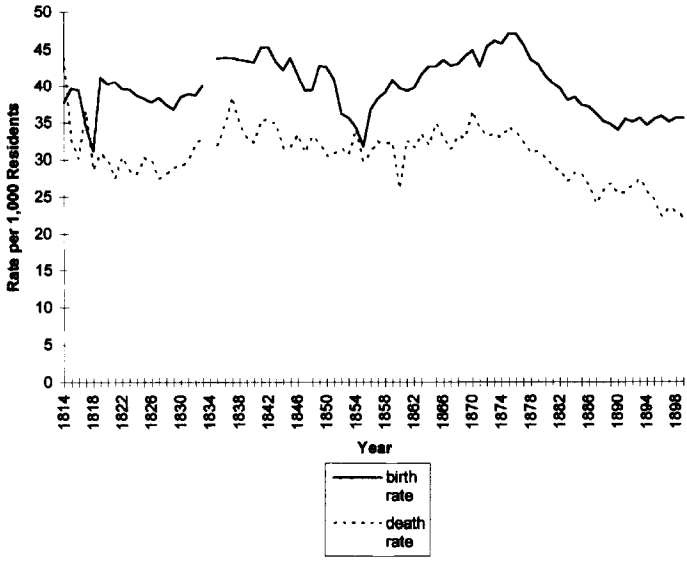

Fig. 8.13 Birth (including stillbirths) and death rates per 1,000 residents in Württemberg, 1814–99
Source: Königliches Statistisches Landesamt (1901).

8.3.4 Mortality Rates

Both Germany and Württemberg went through their demographic transitions in the time period under consideration. Figure 8.12 shows the demographic transition in Germany. Both birthrates and death rates peaked in the 1870s. Thereafter, the trend was downward. Birthrates fell particularly fast between 1895 and 1913, from 36.1 to 27.5 births per 1,000 population. Following the First World War, birthrates peaked for a few years and then remained below 21 births per 1,000 population. Between 1875 and 1934, mortality rates consistently declined (except during the war years), falling from 27.6 to 10.9 deaths per 1,000 population.

Figure 8.13 shows the birth and mortality rates in Württemberg between 1812 and 1897. In the 1820s, mortality rates were relatively low, averaging 29 deaths per 1,000 residents. From the 1830s through the late 1870s, mortality rates were higher, generally in the 31 to 35 deaths per 1,000 range. As in Germany as a whole, a downward trend began in the late 1870s and continued through the end of the century.

Birthrates dropped sharply during the agricultural crisis of the late 1840s and early 1850s but otherwise followed the same basic pattern as mortality rates. This similarity is not surprising when one looks at the information in table 8.9: in the second half of the nineteenth century, deaths of infants comprised 32–47 percent of all deaths in Württemberg. These percentages are ex-

Table 8.9 **Deaths of Infants under Age One as a Percentage of Total Deaths (including stillbirths) in Württemberg, 1846–56 to 1900 (available years)**

Year	Percentage of Total Births	Year	Percentage of Total Births
1846–56	40.1	1879	40.4
1858–59	43	1880	39.6
1859–60	44	1881	38.1
1860–61	41	1882	36.5
1861–62	45	1883	37.4
1862–63	39.5	1884	38.3
1863–64	42.3	1885	35.5
1865	47	1886	38.2
1875	43.6	1894	31.9
1876	42.9	1897	35.9
1877	40.6	1900	35.2
1878	39.4		

Sources: Königliches Medizinal-Kollegium (1896, 1900, 1902), Königliches Statistisches Landesamt (1889, 1901), Königliches Statistisch-Topographisches Bureau (1863a, 1877), and Württembergischer Ärztlicher Verein (1867).

Table 8.10 **Deaths by Age Category as a Percentage of Total Deaths (excluding stillbirths) in Württemberg, 1846–56, 1876–86, 1894, 1897, and 1900**

	Age Category and Percentage of Total Deaths in That Category						
Year	<1	1–6	7–13	14–19	20–44	45–69	>70
1846–56	42.2	10.0	2.4	1.9	10.8	20.7	12.0
		12.4			33.4		

	Age Category and Percentage of Total Deaths in That Category							
Year	<1	1–4	5–9	10–14	15–19	20–44	45–69	>70
1876–86	41.0	10.6	2.6	1.1	1.3	10.2	19.3	13.9
		14.3			30.8			

	Age Category and Percentage of Total Deaths in That Category			
Year	<1	1–15	15–60	>60
1894	33.4	17.4	22.9	26.3
1897	37.6	11.4	23.3	27.7
1900	36.9	10.1	23.0	30.0

Sources: Königliches Medizinal-Kollegium (1896, 1900, 1902), Königliches Statistisches Landesamt (1889), and Königliches Statistisch-Topographisches (1863b).

ceptionally high, often double that in other European countries during that time period (Königliches Statistisch-Topographisches Bureau 1875). Higher birth-rates combined with exceptionally high infant mortality rates drove up the overall mortality rates.

Table 8.10 shows deaths by age category as percentages of total deaths in Württemberg in 1846–56, 1876–86, 1894, 1897, and 1900. The age categories reported were unfortunately not constant across periods. Nevertheless, the trend toward a decreasing percentage of deaths under age 1 and an increasing percentage of deaths over age 60 or 70 is clear.

8.3.5 Causes of Death

According to Omran, there are three phases in a country's epidemiologic transition. Phase one could be termed the age of epidemics and famine. Mortality rates fluctuate a great deal, hindering population growth, and average life expectancy at birth varies from 20 to 40 years. The transitional phase two is the age of declining epidemics. Life expectancy at birth rises from around 30 years to 50 years. Declining mortality rates are followed by declining birth-rates. During phase three, mortality reaches even lower levels, and life expectancy at birth can surpass 70 years. The population becomes increasingly older, causing this age to be called the age of degenerative and man-made diseases (Omran 1971).

According to Reinhard Spree (1986), the transitional phase two began in

Germany around 1820 and lasted until the 1920s. This phase was characterized by the absence of great epidemics, the evolution of the so-called human crowd diseases into children's diseases, and a decline in deaths due to smallpox, typhoid fever, and tuberculosis. The period of study of this paper spans the last two-thirds of phase two and the beginning of phase three.

In the third quarter of the nineteenth century in Württemberg, deaths due to infectious diseases generally accounted for less than 8 percent of all deaths. Toward the end of the nineteenth century, deaths due to infectious diseases were decreasing, whereas deaths due to tuberculosis of the lungs, pneumonia, and other respiratory problems were on the rise and together accounted for 24.6 percent of all deaths in 1900. Approximately one-fifth of all deaths were due to gastroenteritis. Tumors, though accounting for less than 4.5 percent of all deaths, were also on the rise (Königliches Medizinal-Kollegium 1900; Königliches Statistisches Landesamt 1901).

More insight into Württemberg's mortality situation can be gained from table 8.11, which shows causes of death in four age categories in Württemberg in 1900. The victims of infectious diseases were overwhelmingly children. The

Table 8.11 Causes of Death in Four Age Categories in Württemberg, 1900

	Age Category				
Causes of Death	<1	1–15	15–60	>60	Total
Diphtheria	144	821	20	5	990
Whooping cough	768	325	4	7	1,104
Scarlet fever	34	155	16	–	205
Measles	158	204	–	–	362
Typhoid	–	6	136	12	154
Tuberculosis of lungs	198	374	3,338	712	4,622
Tuberculosis of other organs	85	222	234	59	600
Pneumonia	1,086	657	792	1,245	3,780
Other respiratory	753	416	908	1,963	4,040
Gastroenteritis	10,195	608	217	309	11,329
Puerperal fever	–	–	118	–	118
Other consequences of delivery or pregnancy	–	–	148	–	148
Tumor	7	19	911	1,097	2,034
Congenital weakness in first month of life	3,626	–	–	–	3,626
Infirmity (age 60+)	–	–	–	4,512	4,512
Accidents	24	209	457	190	880
Suicide	–	3	277	92	372
Other cited cause	1,588	1,103	4,058	4,972	11,720
Cause not stated	13	10	15	10	48
Total	18,679	5,132	11,649	15,185	50,645

Source: Königliches Medizinal-Kollegium (1902).

chief cause of death for infants under age 1 year was gastroenteritis, accounting for 54.6 percent of all infant deaths. This reflects the lack of breast-feeding in Württemberg and the substitution of nonhygienically prepared infant formulas. For infants, congenital weakness and pneumonia were also particularly lethal.

For children aged 1–15 years, infectious diseases, pneumonia, gastroenteritis, tuberculosis, and other respiratory problems were the main causes of death. For adults aged 15–60, tuberculosis of the lungs was the number one killer, accounting for nearly 29 percent of all deaths in that age category in all three years. This suggests inadequate nutrition and poor living conditions. Pneumonia, other respiratory problems, and tumors were also main causes of death for young and middle-aged adults. For those over age 60, the main cause was infirmity due to old age, followed by respiratory problems, pneumonia, tumors, and tuberculosis of the lungs.

The causes of death in Württemberg can be compared with those in German cities with over 15,000 residents for the years 1877, 1881, and 1884.[20] Infectious diseases accounted for over 10 percent of all deaths in German cities in the late 1870s to early 1880s. Tuberculosis of the lungs, the main cause of death cited, accounted for over 13 percent of all deaths in German cities. This is considerably higher than the 7.6–9.6 percent in Württemberg during the 1890s. However, in Württemberg, the mortality rate due to this illness in 1897 was considerably higher in the cities with populations over 10,000—22.85 lung tuberculosis deaths per 10,000 people as opposed to 18.81 in the rest of the kingdom.[21] Still it appears plausible that Württemberg's cities were healthier places to live than the average German city, perhaps because they were not huge agglomerates. On the other hand, the percentage of deaths caused by enteritis and diarrhea with vomiting was between 9 and 11 percent for German cities, whereas deaths due to gastroenteritis accounted for 18–23 percent of all deaths in Württemberg. This is due primarily to the lack of breast-feeding in Württemberg.

Data on the causes of death in Germany in 1949 clearly indicate that the country had entered phase three of the epidemiologic transition—the age of degenerative and man-made diseases. Deaths due to infectious diseases such as diphtheria, smallpox, and typhoid fever dropped dramatically compared to the previous century. The same was true for tuberculosis of the respiratory system (which now accounted for only 4.1 percent of all deaths) and for diarrhea and enteritis (1.3 percent of all deaths). These large declines point to much improved general health and hygiene conditions. Cancer and heart diseases had become the top two causes of death, causing 15.7 and 15.2 percent, respectively, of all deaths in 1949 (World Health Organization 1950).

20. The data on German cities are from Kaiserliches Statistisches Amt (1886).

21. In Württemberg's cities, however, the mortality rates due to infectious diseases and pneumonia were considerably lower than in the rest of the kingdom (Königliches Medizinal-Kollegium 1900).

8.3.6 Life Expectations

Data on life expectations are available from the founding of the German Empire in 1871 onward. Table 8.12 shows life expectancy at ages 0, 30, and 60 for males and females between 1871–80 and 1974–76 in the German Empire/ Federal Republic of Germany. The trend was clearly upward, particularly for life expectancy at birth. Please note, however, that the figures for 1871–1910 are by decade and thus do not show yearly variations.

For Württemberg, table 8.13 summarizes what I was able to collect and compares life expectancies in the region with the German average. Württemberg's life expectancy trend was clearly positive between 1876–80 and 1900–10, for both males and females, and at all ages shown (0, 1, 2, 6, 30, and 60 years). Life expectancy at birth showed the greatest increase: for males this rose from 34.3 years in 1876–80 to 45.15 years in 1901–10. For females, it increased from 36.76 years to 48.08 years. This largely reflects declining infant mortality rates. Compared to the overall German average, females in Württemberg generally lived shorter lives throughout the periods studied. Württemberg's males generally improved their life expectancy relative to the German average.

Table 8.12 **Life Expectancy at Ages 0, 30, and 60 for Males and Females in the German Empire, 1871–80 to 1974–76**

	Age 0		Age 30		Age 60	
Period	Male (1)	Female (2)	Male (3)	Female (4)	Male (5)	Female (6)
1871–80	35.58	38.45	31.41	33.07	12.11	12.71
1881–90	37.17	40.25	32.11	34.21	12.43	13.14
1891–1900	40.56	43.97	33.46	35.62	12.82	13.60
1901–10	44.82	48.33	34.55	36.94	13.14	14.17
1910–11	47.41	50.68	35.29	37.30	13.18	14.17
1924–26	55.97	58.82	38.56	39.76	14.60	15.51
1932–34	59.86	62.81	39.47	41.05	15.11	16.07
1946–47	57.72	63.44	39.20	42.72	15.18	16.99
1949–51	64.56	68.46	41.32	43.89	16.20	17.46
1958–59	66.75	71.88	41.39	45.30	15.74	18.27
1959–60	66.69	71.94	41.21	45.27	15.53	18.22
1960–62	66.86	72.39	41.14	45.53	15.49	18.48
1962–63	67.10	72.77	41.02	45.64	15.33	18.55
1963–64	67.32	73.13	41.10	45.84	15.40	18.75
1964–66	67.58	73.48	41.17	46.03	15.46	18.92
1966–68	67.55	73.58	41.04	46.04	15.29	18.88
1968–70	67.24	73.44	40.75	45.90	15.02	18.77
1970–72	67.41	73.83	41.00	46.30	15.31	19.12
1972–74	67.87	74.36	41.24	46.70	15.52	19.46
1974–76	68.30	74.81	41.36	46.95	15.64	19.66

Source: See Wiegand and Zapf (1982).

Table 8.13 **Life Expectancy for Males and Females in Württemberg and Germany in the Late Nineteenth and Early Twentieth Centuries**

Age In Years	1876–80	1871–80	1891–1900		1901–10	
	Württemberg	German Empire	Württemberg	German Empire	Württemberg	German Empire
Males						
At birth	34.3	35.58	39.74	40.56	45.15	44.82
Age 1	49.2	–	52.97	51.85	56.67	55.12
Age 2	51.5	–	54.25	53.67	57.53	56.39
Age 6	51.3	–	53.15	52.70	55.01	54.44
Age 30	32.8	31.41	33.95	33.46	34.94	34.55
Age 60	12.1	12.11	12.71	12.82	13.00	13.14
Females						
At birth	36.76	38.45	42.74	43.97	48.08	48.34
Age 1	49.8	–	53.87	53.78	57.62	57.20
Age 2	52.2	–	55.17	55.59	58.33	58.47
Age 6	52.0	–	54.16	54.66	56.04	56.57
Age 30	33.2	33.07	35.01	35.62	36.36	36.94
Age 60	12.2	12.71	12.98	13.60	13.69	14.17

Sources: Constructed from table 8.12 and Königliches Statistisches Landesamt (1913a).

8.3.7 Migration

Emigration from a region can be due to a number of factors, including high population density and growth and unfavorable economic conditions coupled with brighter prospects elsewhere. Thus, a surge in emigration could indicate a period of hardship in the home country. Table 8.14 shows the substantial net population loss due to migration for Württemberg during 12 phases between 1816 and 1900. The years 1847–55, the time of the agricultural crisis and economic downturn, had the highest emigration rates. Eighteen thousand people—approximately 1 percent of the population—left per year, many of whom headed for North America. Emigration in the early 1850s was so high that Württemberg's population actually declined from 1,733,263 in 1852 to 1,720,708 in 1861, despite high birthrates (Megerle 1982). The early 1880s had the second highest emigration rate; the late 1860s to early 1870s had the third highest. As can be seen in table 8.15, the emigration patterns for Germany as a whole are similar to those for Württemberg.

8.3.8 Average Workday and Workweek

Table 8.16 shows the trends in the average workday and workweek in German industry from 1800 (1830) to 1914. The average workday and workweek were highest in the 1830–60 period, when the average workday was 14–16 hours and the average workweek was 80–85 hours. Thereafter, the trend was

Table 8.14 **Loss of Population Due to Emigration from Württemberg, 12 Phases, 1816–1900**

Period	Migration Loss	
	Total	Per Year
1816–18	20,000	6,670
1819–28	16,500	1,650
1829–34	30,500	6,100
1835–46	36,000	3,000
1847–55	162,000	18,000
1856–64	45,000	5,000
1865–70	43,000	7,170
1871–73	14,913	4,970
1874–79	8,492	1,420
1880–84	47,707	9,540
1885–93	50,211	5,580
1894–1900	11,824	1,690
1816–1900	486,142	5,720

Source: Megerle (1982).

Table 8.15 **Overseas Emigration from Germany**

Period	Total
1821–30	8,500
1831–40	167,700
1841–50	469,300
1851–60	1,075,000
1861–70	832,700
1871–80	626,000
1881–90	1,342,400
1891–1900	529,900
1901–10	279,600
1911–20	91,000
1921–30	567,300
Total	5,989,400

Source: Stolper (1940).

downward. In the 1870s, the average workday was 12 hours. By 1911–14, on average 54–60 hours were worked per week, and 10 hours per day.

The story in Württemberg was similar. Although there was a fair amount of variation in working hours across different industrial branches, in the 1870s, the usual workday was 11–12 hours (without breaks). Many factory workers actually preferred working three 24-hour shifts since they lived in rural areas and traveled a relatively long way to get to work. By the turn of the century, roughly 10–11 hours were worked per day. In 1912, over 60 percent of Württemberg's workers worked 57 hours or less per week (Boelcke 1989).

Table 8.16 **Development of Average Workday and Workweek in German Industry, 1800–1914**

Period	Average Workday (hours)	Average Workweek (hours)
Around 1800	10–12	–
Around 1820	11–14	–
Around 1830–60	14–16	80–85
1861–70	12–14	75
1871–80	12	72
1881–90	11	66
1891–95	10.5–11	63–65
1896–1900	10.5	61–63
1901–5	10–10.5	59–61
1906–10	10–10.5	58–60
1911–14	10	54–60

Source: Wiegand and Zapf (1982).

8.3.9 Hoffmann's Index of Caloric Balance

Using aggregate data on German consumption of 26 categories of food and drink, Hoffmann (1965) calculated the estimated total number of calories consumed in Germany for each year between 1850 and 1959. He then figured out how many calories the population needed by age and sex,[22] adding additional calories for work (130 calories per hour worked in factories, agriculture, mining, and crafts; 500 calories per day in other kinds of work; 600 per day for housewives) and 150,000 calories per birth.

He then compared the calories consumed to those needed. Table 8.17 shows the results. In 1850–54, only 75 percent of calories needed were consumed. When one takes into account that food consumption was not evenly distributed, it is evident that many Germans were consuming considerably less than 75 percent of the calories they needed. The situation improved, reaching 100 percent (on average) in 1875–79. The ratio fell to 95 percent in 1880–84. Thereafter, it remained above 100 percent. Until 1900–1904, it rose steadily. Afterward, it declined and then steadied out in the 1930s at 111 percent.

The caloric deficits before the late 1880s almost certainly led to some stunting of stature in Germany. The period of most extreme caloric deficit (1850–54) corresponds to extremely short statures for those born in Württemberg during that period. The secular increase in heights did not begin prior to the mid-1890s, when Hoffmann's index of actual to needed calories rose to 119.

22. Hoffmann estimated, e.g., that children under six years of age normally need 1,000 (male) and 950 (female) calories per day. Adolescents (ages 14–19) need 2,800 (male) and 2,400 (female) calories per day. Adults (ages 20–44) need 2,400 (male) and 2,200 (female) calories per day. For more details, see Hoffmann (1965, 658).

Table 8.17 Hoffmann's Index of Caloric Balance, 1850–1950

Year	Actual (billion Kcal)	Needed (billion Kcal)	Actual/Needed (%)
1850–54	27,730	36,750	75
1855–59	30,240	37,650	80
1860–64	34,980	39,340	89
1865–69	36,710	40,860	90
1870–74	39,140	43,400	90
1875–79	46,530	46,440	100
1880–84	46,130	48,530	95
1885–89	52,850	50,610	104
1890–94	57,670	53,250	108
1895–99	67,410	56,860	119
1900–1904	74,620	60,820	124
1905–9	79,160	65,140	122
1910–13	81,530	69,100	118
1925–29	74,540	68,860	108
1930–34	76,440	68,650	111
1935–38	80,440	72,430	111
1950–54	56,490	50,800	111
1955–59	61,390	54,080	114

Source: Hoffmann (1965).

There is a good chance that in this period, despite some income and caloric inequality, the majority of the German population was eating enough to largely meet its caloric needs (although less can be said about its nutritional, particularly protein, needs). This, combined with rising incomes, improved hygiene and public health measures, and possibly better breast-feeding practices, is what most likely drove the secular increase in heights during the twentieth century.

8.3.10 Literacy Rates

Illiteracy was fairly rare in Germany and in Württemberg throughout the period studied. Table 8.18 shows the percentage of recruits in Germany and Württemberg who were illiterate in the period 1881–82 to 1912.[23] For the purposes of the German army, being literate meant being able to read "enough" and to write one's first and last name legibly. This is obviously a looser definition than would be used today, but it can still be indicative.

For Germany as a whole, there was a clear downward trend in the already low illiteracy rates. The percentage of illiterate soldiers fell from 1.54 percent in 1881–82, to 0.72 percent in 1886–87, to 0.22 percent in 1894, and to 0.07

23. I was unable to find hard data on literacy rates for all of Germany prior to the last quarter of the nineteenth century. Between 1875 and 1881, the literacy rate for German recruits was 98 percent. For earlier years, some data are available on literacy rates of Prussian recruits: 1841, 91 percent; 1851, 95 percent; 1865, 94 percent; and 1867–74, 96–98 percent (Cipolla 1969).

Table 8.18 **Illiteracy Rates (in percentages) of German and Württemberg Recruits, 1881–82 to 1912 (available years)**

Year	Germany	Württemberg	Year	Germany	Württemberg
1881–82	1.54	0.00	1898	0.07	0.02
1882–83	1.32	0.00	1899	0.05	0.03
1883–84	1.27	0.02	1900	0.07	0.00
1884–85	1.21	0.03	1901	0.05	0.01
1885–86	1.08	0.00	1902	0.04	0.04
1886–87	0.72	0.00	1903	–	0.03
1887–88	0.71	0.01	1904	0.04	0.03
1888–89	0.60	0.03	1905	0.03	0.06
1889–90	0.51	0.01	1906	0.02	0.06
1890–91	0.54	0.04	1907	0.02	0.07
1892	–	–	1908	0.02	0.00
1893	0.24	0.01	1909	0.02	0.01
1894	0.22	0.03	1910	0.02	0.02
1895	0.15	0.03	1911	0.01	0.01
1896	0.11	0.03	1912	0.05	0.01
1897	0.08	0.02			

Sources: Königliches Statistisches Landesamt (1892, 1901, 1903, 1910a, 1912, 1913a).

Note: Literacy rate is defined as the percentage of recruits who could write their names and read sufficiently.

percent in 1900. From 1901 through 1912, it ranged from 0.01 to 0.05 percent. In Württemberg, the illiteracy rate in this period was never above 0.07 percent, and it generally ranged between zero and 0.03 percent. After 1912, it was generally believed that illiteracy had been virtually stamped out in Germany (Giese 1986).

8.3.11 The Human Development Index

Economic expansion is only a means to the end of human well-being. In recent years, the United Nations Development Programme (UNDP) has attempted to quantify human well-being or human development in a manner allowing comparisons between countries. According to the UNDP, "Human development is a process of enlarging people's choices. The most critical ones are to lead a long and healthy life, to be educated and to enjoy a decent standard of living. Additional choices include political freedom, guaranteed human rights and self-respect" (United Nations Development Programme 1990). Since quantifying all of the above factors can be difficult, UNDP decided to focus on the first three essential elements of human life in creating its Human Development Index (HDI).

The HDI has three components. For the first—longevity—life expectancy at birth is used as the indicator. For the second—education and knowledge—literacy rates are the chosen proxy. For the third—"command over resources needed for a decent living"—the logarithm of purchasing-power-adjusted real GDP per capita was chosen.

For each component, the minimum and maximum ranges must be defined. In 1990, the UNDP used the lowest 1987 national values for each indicator as the minimum. These were 42 years for life expectancy, 12 percent for literacy, and $220 for real per capita income. For the maximum, they used Japan's life expectancy in 1987 of 78 years, 100 percent literacy rate, and the average official poverty line in developed countries, $4,861. An index value was calculated for each component in each country. The HDI is a composite index, with each component given equal weight (United Nations Development Programme 1990).

To apply this method to historical data, some changes must be made in the minimum and maximum values used. For example, in many European countries in the nineteenth century, life expectancy was less than 42 years, so the minimum value must be lower. There is a need for economic historians to develop a common methodology for constructing historical HDIs to facilitate comparison between countries.

For historical Germany, the available data that have been presented earlier in this paper were used to construct the HDI index. Table 8.12 contains information on life expectancy at birth; table 8.18 contains information on literacy rates of German soldiers; table 8.3 contains data on real per capita NNP in 1913 prices, which is the historical time series available that is closest to purchasing-power-adjusted real GDP per capita.

The ranges used for the three component indices are for life expectancy, minimum = 30 years and maximum = 80 years; for literacy, minimum = zero percent and maximum = 100 percent; for real per capita income, minimum = DM 298 (log(298) = 2.474) and maximum = DM 1,186 (log(1,186) = 3.074)—the minimum and maximum real per capita NNP in 1913 prices during the period studied.[24]

Table 8.19 shows the indexes obtained for the three indicators, as well as the HDI for periods between 1871 and 1950. The HDI rose throughout the period, driven almost exclusively by increases in longevity and real per capita income, since literacy rates were very high throughout the period. The HDI's total increase was 37.47 points. This amounts to an average increase (using the midpoint of the first period as a starting point) of 0.5 points per annum.

Columns (6) and (7) show the changes in the HDI between periods. As can be seen in column (7), the average annual HDI increase between 1871–80 and 1881–90 was below the average for the period: the gains in life expectancy and real per capita income were relatively small. The HDI was increasing particu-

24. The choice of ranges for the three indexes comprising the HDI is not inherently obvious. This is particularly true for purchasing-power-adjusted real per capita income. Using the actual minimum and maximum values observed allows the tracking of a country's income development during the period of interest. It does not, however, greatly facilitate comparisons with other countries' income development. For this, a standard methodology needs to be adopted by all. The minimum value could be defined either as zero or the cost of a subsistence diet (also to be defined). The maximum value could be the highest per capita income level ever attained, the official poverty level in a specified country and year, or the cost of a certain bundle of goods and services. Defining an easily adoptable historical HDI is a rich area for future collaborative research.

Table 8.19 **A Human Development Index (HDI) for Germany, 1871–80 to 1950**

	Indexes				HDI Increase	
Years (1)	Life Expectancy at Birth (2)	Literacy (3)	Real Per Capita Income (4)	HDI (5)	Total (6)	Per Year (7)
1871–80	14.03	97.4	33.50	48.31		
1881–90	17.42	99	38.17	51.53	3.22	.322
1891–1900	24.53	99.89	53.00	59.14	7.61	.761
1901–10	33.15	99.97	62.67	65.26	6.12	.612
1910–12	38.09	99.99	67.83	68.64	3.38	.615
1924–26	54.79	99.99	66.5	73.76	5.12	.366
1932–34	62.67	99.99	64.17	75.61	1.85	.231
1950	73.02	99.99	84.33	85.78	10.17	.598

Sources: Calculated from tables 8.3, 8.12, and 8.18 and Cipolla (1969).

Notes: The ranges used for the three single indexes are, for life expectancy, minimum = 30 years and maximum = 80; for literacy, minimum = zero percent and maximum = 100 percent; for real per capita income, minimum = DM 298 and maximum = DM 1,186—the minimum and maximum real per capita income over the period. The HDI is simply the average of the three single indexes. For life expectancy, data are for 1910–11 instead of 1910–12 and 1949–51 instead of 1950. The life expectancy used is the average of the rates for males and females. For real per capita income, data are for 1925–26 instead of 1924–26. For literacy, the 1910–12 value (99.99 percent) has been used for the later time periods.

larly fast between 1881–90 and 1891–1900, at an average annual rate of 0.76 points. Between 1910–12 and 1932–34, the rates were below average: the considerable increases in life expectancy were partially offset by declines in real per capita income during the global economic downturn. Despite World War II, Germany's HDI rose considerably between 1932–34 and 1950 (an average rate of 0.6 points per annum). The HDI's 10-point rise was driven by 10-point increases in both the life expectancy and real per capita income indexes.

Table 8.20 displays an alternative Human Development Index for periods between 1851 and 1950 using average population heights in the place of life expectancy. The height estimates used in constructing the table are from table 8.4 (RSMLE estimates for two-year birth cohorts of Württemberg recruits), Harbeck's (1960) recorded average height for draftees born in 1937 in Germany (173.2 cm) and in Baden-Württemberg (171.8 cm), and Jürgens's stature estimates for 20-year-old draftees born in 1948–49 in Germany (176.3 cm) and in Baden-Württemberg (176.8 cm). The range for the height index is 156 cm to 180 cm.[25]

Between 1851–60 and 1950, the alternative HDI rose by 44.2 points—an

25. The bottom of the height range, 156 cm, is the average height of the Bundi of New Guinea—one of the shortest populations ever measured. The top, 180 cm, is approximately the average height attained by the tallest populations today. The selection of this range implies that an increase in average stature of 0.24 cm increases the stature index by one point. Choosing a narrower range for stature would cause changes in stature to have a larger impact on the overall HDI.

Table 8.20 **An Alternative Human Development Index for Germany, 1851–60 to 1950**

Year	Average Height Index	Alternative HDI	HDI Increase	
			Total	Per Year
1851–60	34.12	45.43		
1861–70	41.46	52.32	6.89	.689
1871–80	39.48	56.79	4.47	.447
1881–90	42.77	59.98	3.19	.319
1891–1900	46.62	66.50	6.52	.652
1932–34	71.67	78.61	12.11	.323
	(65.83)	(76.66)	(10.16)	(.271)
1950	84.58	89.63	11.02	.648
	(86.67)	(90.33)	(13.67)	(.804)

Sources: Calculated from tables 8.3, 8.4, and 8.18, Cipolla (1969), Harbeck (1960), and Jürgens (1971).

Notes: The indexes for income and literacy are the same as in table 8.19, expanded by two decades. The income is 7.17 for 1851–60 and 20.5 for 1861–70. The literacy index for these two decades has been estimated from Prussian data to be 95. The time periods used for the height data (birth years 1852–61, 1860–71, 1870–81, 1880–91, 1890–1900, 1937, and 1948–49) are slightly different than those used for literacy and income. The height estimates for birth years 1851–93 are for the kingdom of Württemberg; for 1937 and 1948–49, they are for all of Germany, with the estimate for Baden-Württemberg in parentheses. The height index is based on a range from 156 to 180 cm.

average increase of 0.47 points per annum. The pattern is similar to that seen in the standard HDI. The rate of increase was lower than average between 1871–80 and 1881–90 (0.319), as well as between 1891–1900 and 1932–34 (0.323). The rate of increase was higher than average between 1881–90 and 1891–1900, as well as between 1932–34 and 1950.

For historical Germany, I prefer to use the standard HDI. The reason for this preference is that life expectancies from 1871 onward were calculated for all of Germany. The height data available before 1932 are simply for one part of Germany. However, it is reassuring that the two HDIs and their changes are rather similar. When data on one indicator are lacking, it seems plausible to substitute the other. Both HDIs indicate a rise in human development that was particularly rapid around the turn of the century.

8.4 Discussion and Conclusions

In the preceding pages, evidence on a range of indicators of health and well-being in Germany has been presented. From the middle of the nineteenth century to the middle of the twentieth, living standards in Germany undoubtedly improved. Real per capita NNP (in 1913 prices) more than tripled. The average workweek in German industry declined by more than 20 hours. Average male stature in Württemberg rose by over 15 cm—from the 0.7th to the 50th percentile of modern height standards. Hoffmann's index of caloric balance rose from

75 to 111. German mortality rates were cut in half. Between 1881 and 1937, infant mortality rates fell by over two-thirds. Between 1871–80 and 1949–51, life expectancy at birth increased by more than 29 years, and the Human Development Index rose by over 37 points.

Yet this upward trend was not always smooth. German living standards were increasing particularly fast in some periods and stagnating or even declining temporarily in others. Let us take a closer look at the trends between 1850 and 1939.

In the late 1840s to early 1850s, there was a severe agricultural crisis in Württemberg and an economic downturn throughout Germany. This corresponded to a period of very high emigration rates and extremely low average heights: the RSMLE height estimate of 160.56 cm[26] for 20-year-old males born in Württemberg in 1852 and 1853 is below the 1st percentile of modern height standards. Hoffmann's index of caloric balance indicated that the German population was consuming only 75 percent of the calories actually needed. Kuczynski's index of real wages showed a huge decline for the 1852–56 period. Clearly, these were not easy times for most Germans.

Recovery followed during the late 1850s and the 1860s. Once the agricultural crisis in Württemberg was over, average male heights increased by about 6 cm to 166.69 cm for the birth cohorts of 1866–67 (approximately the 6th percentile of modern height standards). This sizable improvement in net nutrition corresponded to a rise in Hoffmann's index of caloric balance from 75 to 90. German mortality rates fell during the 1850s but began to rise in the late 1860s, in part due to the Franco-Prussian War and perhaps to increasing urbanization.

In 1871, the German states were united under the umbrella of the German Empire. The early 1870s were boom years characterized by very high inflation rates (fueled by French reparation payments made ahead of schedule), an optimistic spirit, and massive speculation. The financial crash came in mid-1873 and ushered in the period known as the great depression (1873–96). Throughout Germany, there were many bankruptcies and economic growth slowed. Prices, profits, and wages fell while unemployment rose.

During this Founder's Crisis, real per capita NNP (in 1913 prices) fell from DM 507 in 1874 to DM 441 in 1880. This corresponded to a marked decline in average heights for those born in the 1870s (reaching the 3d percentile of modern height standards) and to high German mortality rates, which peaked in the mid-1870s. (In Württemberg, mortality rates peaked in 1870 and again in 1875.) On the other hand, emigration rates were not particularly high and Hoffmann's index of caloric balance rose from 90 in 1870–74 to 100 in 1875–79. Yet if income inequality was rising during the 1871–1914 period as Dumke (1988) claims and occupational height trends confirm, many of the additional calories could have gone to the better-off, leaving the net nutrition of the aver-

26. RSMLE estimate for two-year birth cohort.

age German the same as or even lower than before. Overall, the 1870s seem to have been a time of stagnation and possibly declines in the health and living standards of the average German. At the very least, pessimists' claims cannot be ruled out.

The 1880s is another period when the evidence is mixed but seems to point to a stagnation in the upward trend in German health and living standards. Optimists would point to rising real per capita NNP after 1882 (from 447 in 1882 to 564 in 1890), a small increase in literacy rates, and declining mortality rates (from 25.7/1,000 in 1882 to 24.4 in 1890). These factors drove an increase in the HDI of 3.22 points between 1871–80 and 1881–90. Pessimists would counter that the average annual rate of HDI change (0.322) was much lower than the average for the whole 1871–80 to 1950 period (0.5 per year). Indeed, the only period with a slower rate of HDI change was that ending with the Great Depression.

The pessimists have additional ammunition for their arguments. By 1880–81, average heights in Württemberg had recovered to reach their 1866–67 level. But then there was a second dip in stature, reaching its nadir with the birth cohorts of 1884–85. Some recovery followed, but stature did not regain its 1866–67 level again until 1892–93. So nearly 30 years passed with no significant improvement in net nutrition. The fall in heights in the 1880s corresponded to a decline in Hoffmann's index of caloric balance to 95 in 1880–84 and to huge increases in emigration, both from Germany and Württemberg.

For the period from 1890 until the First World War, both optimists and pessimists would have to agree that health and living standards in Germany were on the rise. Emigration rates dropped dramatically. Hoffmann's index of caloric balance rose from 108 in 1890–94 to 122 in 1905–9. The height data unfortunately ended with the birth cohort of 1893 but showed positive trends in the early 1890s. Life expectancy at birth rose by over 10 years—from 38.7 years in 1881–90 to 49 years in 1910–11. Between 1890 and 1913, German mortality rates fell from 24.4/1,000 to 15/1,000; infant mortality and stillborn rates fell from 255.5/1,000 live births to 181/1,000; real per capita NNP increased from DM 564 to DM 783. The HDI rose from 51.53 in 1881–90 to 68.64 in 1910–12. Clearly, the average German's standard of living and health improved considerably during this period.

During World War I, no data are available for most living standard indicators. We do know, however, that real per capita NNP dropped from DM 783 in 1913 to DM 751 in 1925 and German mortality rates jumped from 15/1,000 in 1913 to an average of 20.7/1,000 in 1914–18. Furthermore, the declines in stature of schoolchildren in Stuttgart indicate that the net nutrition of the civilian population declined during the war years. In addition, the psychological costs of war are always high albeit difficult to quantify. Clearly, the quality of life in Germany declined during the First World War.

Between the two world wars, Germans' health and welfare were generally improving. Real per capita NNP was rising from 1926 to 1928, declined during

the 1929–32 Great Depression years, and rose rapidly during the armaments buildup of 1933–38. All health indicators showed positive trends throughout the interwar period, even during the Great Depression. Life expectancy rose by nearly four years between 1924–26 and 1932–34. This caused the HDI to rise by nearly two points, even though real per capita NNP had declined. Between 1919 and 1938, German mortality rates fell from 15.6/1,000 to 11.7/1,000; infant mortality and stillborn rates fell from 151.6 per 1,000 live births to 83.3. As figure 8.10 indicates, height trends and thus net nutrition were steadily positive (at least in Stuttgart). Hoffmann's index rose from 108 in 1925–29 to 111 in 1930–34 and 1935–38. Thus, despite the business cycle downturn during the Great Depression, the health and physical living standards of Germans clearly rose during the interwar period.

In summary, health and living standards in Germany improved considerably between 1850 and 1939. Yet progress was not always smooth. Particularly during the 1870s and 1880s, there are indications that the beginning of rapid industrialization was accompanied by some hardship for the German people. Thereafter, however, with the exception of the war years, most Germans experienced steady improvements in their health and living standards.

Appendix
Sampling Procedure and Methodology[27]

Information was collected on nearly 15,000 soldiers serving in the army of Württemberg between 1871 and 1913. For all observations, information was recorded on height, occupation (of the soldier and, where available, of his father), birthplace, and birth date. For approximately half of all observations, residence information was recorded. For approximately 20 percent, medical history was recorded.

The sample was drawn from the infantry, cavalry, and artillery in proportions reflecting the composition of the army. Most of the observations therefore came from the infantry. The infantry had eight (later ten) regiments, each drawn from different regions. To maintain geographical balance, records were drawn from each regiment for every two-year period. Each regiment had 12 companies, with noticeable sorting by height across companies. Thus it was necessary to draw observations randomly from each company.

Thanks to the universal draft law, the selectivity issues present with volunteer armies do not arise here. However, due to minimum height laws (157 cm until 1893; 154 cm thereafter) and physical examinations, the height distributions of the soldiers tend to be eroded at the lower tail. Thus, simple means

27. For more details on these topics, see Twarog (1993).

will overestimate true population means, and differences between groups will be underestimated. Three statistical methods were used in this study to deal with the above-mentioned scenario: Reduced Sample Maximum Likelihood Estimation (RSMLE), Quantile Bend Estimation (QBE), and the simple mean of the reduced sample.

The RSMLE approach truncates the lower tail of the distribution above the extent of erosion. Then standard maximum likelihood estimation is performed using the probability distribution of the truncated normal distribution. The RSMLE method can also be used for truncated regression aimed at estimating the covariates of heights.[28]

The QBE method plots the quantiles (i.e., centiles, etc.) of the observed distribution against those of the standard normal distribution. A straight line indicates the ranges where the distribution conforms to a normal distribution. At the lower eroded tail, the curve bends. The amount of observations missing from the observed distribution (i.e., the shortfall) is estimated by determining which quantity of shadow observations added to the lower tail generates the straightest quantile plot in the uncontaminated range. Once this is done, the population mean and standard deviation can be estimated from the slope and intercept of a robust regression line fitted to the uncontaminated range of the quantile plot.[29]

Komlos and Kim (1990) developed an alternative method of measuring height trends. Assuming a constant standard deviation and a given truncation point, the mean of the truncated normal distribution is an increasing function of the mean of the underlying distribution. Thus changes in the mean of the reduced sample reflect changes in the population mean. To deduce the actual average population height and standard deviation, they employ RSMLE or QBE methods for a base year.

For the height data collected, all three methods were used. For the RSMLE and Komlos and Kim methods, the reduced sample comprised those soldiers with heights greater or equal to 163 cm. This was chosen on the basis of a priori knowledge (i.e., minimum height standards of 157 and then 154 cm)[30] and limit testing (i.e., chopping off successive height cells to see at which point the mean estimates converge).

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28. For details on this method, see Greene (1990) and Trussell and Wachter (1984).

29. For details and examples of the QBE method, see Wachter and Trussell (1982).

30. Although the minimum height standard until 1893 was 157 cm, those shorter than 162 cm had to be exceptionally healthy and strong to be accepted.

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