

The ranks of death: secular trends in income and mortality*



Stephen J. Kunitz¹ and Stanley L. Engerman²

¹*Department of Community and Preventive Medicine, University of Rochester Medical Center, 601 Elmwood Avenue, Rochester, NY 14642, USA*

²*Department of Economics, Hark 203, University of Rochester, Rochester, NY 14627, USA*

I've been rich, and I've been poor, and rich is better - Pearl Bailey

Abstract

This paper is about the reasons why there is so rarely a strong association between the secular trend in real wages and mortality. We classify the reasons in several different categories: epidemiological, sociological, geographical, demographic, technologic, and economic. In addition, we offer some speculations on why there has been an expectation that such an association would exist. We suggest that this expectation is found primarily in British work (including Britain overseas) and has to do with the history of the British experience of industrial and economic growth and its pervasive interpretations.

Introduction

That the secular trends in *per capita* income or real wages do not invariably predict the secular trend in mortality is on the face of it surprising, for everyday experience suggests to us, as it did to our ancestors, that it is better to be rich than poor, and that the life chances of the rich are generally better than those of the poor. Nonetheless, as Wrigley and Schofield (1981:310–332), have shown using several centuries' worth of British data, the association between real wages and mortality is only evident in a few years of significant economic decline, and many years of crisis mortality were not preceded by declines in wages.¹ Livi-Bacci (1990:99-107), has summarized comparable data from other European populations, and Pope (1992), as well as others, has demonstrated a comparable

*Our initial assignment from John Landers, the conference organizer, was to discuss why the usual expectation of a secular relationship between changing real wages and changing mortality was not always realized. We more broadly interpreted the question to relate to class and status ('rank') differences in mortality. It should be clear that the 'ranks of death' we refer to differ from those suggested in the pioneering work of P.M. Ashburn as well as its use in the familiar poem by Thomas Moore:

*The Minstrel Boy to the war has gone
In the ranks of death you'll find him.*

¹ It should be noted that while the expected relationships would be between income and mortality, the longer availability of estimates for real wages than for incomes means that many historical studies use the former as a proxy for the latter. In addition, there are rather complex issues relating to the expected form of the relationship between income and mortality which will influence the nature of the procedures used for analytical purposes. These reflect not only the specifics of the epidemiological relationship between income-related variables and mortality but also the statistical procedures used in examining the long-term time series in which there are attempts to distinguish secular trends from business cycles.

phenomenon in the United States in the nineteenth century: in the antebellum period, at a time of rapid economic expansion, life expectancy of native-born white Americans was actually deteriorating.

In this paper we shall describe secular patterns of change in income and mortality; suggest some of the reasons why commonsense observations of the association between income and life chances are not reflected in the secular association between them; explore some of the reasons why, however, such a relation has commonly been assumed to be the case; and discuss some ways of thinking about the causes of disease and death that may be applicable to considerations of the impact of real wages and income on mortality.

Secular changes in income and mortality

One of the major characteristics of the modern world has been a substantial secular decline in death rates at all ages as well as a marked diminution in fluctuations in mortality from one year to the next. Starting most dramatically with eighteenth-century Britain, the declines spread to most of the developed nations of Europe and its overseas extensions in the nineteenth century, and then in the twentieth century to most of the rest of the world (see Table 1). For the developed nations, of the 25-point decline in crude death rates between 1750 and 1970 20 per cent occurred before 1900 and over one-half after the First World War. For the less-developed regions, of the estimated 20-point decline in death rates, all occurred in the twentieth century, more than one-half coming in the post-World War II era. The decline in fluctuations in death rates, a precondition to any sustained mortality decline, occurred first in the developed nations by the early nineteenth century, whereas in less-developed parts of the world such dampening occurred much later in the nineteenth century.²

With the well-known divergence between developed and less-developed nations in the growth and levels of *per capita* income over this period, there was a sharp change in the cross-national relation between income and mortality. The initial differences in mortality before the widespread onset of modern economic growth appeared relatively minor, at least in comparison with those which emerged in the epoch between the middle of the nineteenth century and World War II. After World War II, the accelerated mortality decline in the less-developed nations meant a narrowing of the worldwide gap, and a movement toward the narrower differentials of the more distant past. Such narrowing has continued, at least into the 1980s, and, even while aggregate differences in mortality remain which appear correlated with income levels, these appear relatively small by historical standards.³

Table 1

Estimated and conjectured average annual crude birth rates, crude death rates, and rates of natural increase for currently more developed and less developed regions, from 1750 to 1970 (rates per 1,000 per year)

Period	More-developed regions			Less-developed regions		
	Birth rate	Death rate	Natural increase	Birth rate	Death rate	Natural increase
1750–1800	38	34	4	41	37	4

² Sources: Stolnitz (1955); Kuznets (1966:Chap. 2); United Nations (1973: Vol I. Chap. 5); Flinn (1981); World Bank (1990:230–231).

³ See Gwatkin (1980), and Stolnitz (1955). There may be some reversal of the decline in the less-developed nations, but mortality rates still will be lower than they had been earlier. Nevertheless, the crude death rates in the lowest-income region in sub-Saharan Africa in the 1980s are below the rates in the developed nations before World War I.

1800–1850	39	32	7	41	36	5
1850–1900	38	29	9	40	38	2
1900–1910	34	21	13	41	34	7
1910–1920	26	23	3	40	37	3
1920–1930	28	16	12	41	31	10
1930–1940	22	14	8	41	29	12
1940–1950	20	15	5	40	28	12
1950–1960	22	10	12	43	22	21
1960–1970	20	9	11	41	17	24

Source: United Nations (1971:Table 3)

Clearly these mortality changes seem related to what some would call modern economic growth or, used descriptively, modernization. The concept of modernization often includes, among other things: substantial growth in income; an eventual narrowing of the distribution of income among individuals and families within a nation; an increased role for the government in the provision of goods and services within the economy; a broadened application of the results of modern science and technology; a shift in the location of population from rural to urban areas; and a reduction in the share of production in the agricultural sector and increase in the share from industry and services.⁴ Such changes are not inevitable, for it is clear that not all nations have experienced all or even some of these changes. It does appear that as economic growth, or the desire to achieve growth, has spread, many of these features have emerged in less-developed nations, even though it is possible for major social and economic changes to occur without the accompanying full range of modern development, and for some countries or parts of countries to remain backward even though the population may wish for economic growth and modernization. Thus, for example, the diffusion of modern technology may permit changes in a country that are seemingly not related to the level of its national income.

Britain, the first industrial nation, had a pattern of mortality decline basically consistent with that of the developed nations described above. Indeed, both because it paradigmatically typifies the expectations of modernization and also because of the great depth of historical research on the issue, Britain is no doubt the nation whose mortality decline has been most studied and which has therefore done most to set the terms of the ensuing debate. According to Fogel's (1986) calculations of standardized death rates, from 1700 to 1980 the British death rate fell to a quarter of its earlier level, from 28 per 1,000 to seven per 1,000, with 80 per cent of this decline occurring after 1850, and about a half of the overall decline occurring in the twentieth-century. According to Crafts's (1985:44-47) estimates, British economic growth averaged 0.3 per cent per annum in the years 1700 to 1830. Matthews, Feinstein and Odling-Smee (1982:22), indicate that the British growth of Gross Domestic Product per man-year averaged about 1.2 per cent per annum from 1856 to 1973. Clearly, the accelerated increase in the growth of *per capita* income is associated with an accelerated decline in mortality, as well as with dramatic shifts in the location of the population from rural to urban areas, and with significant changes in the contribution of various diseases to mortality; a shift from epidemics to endemic infectious diseases and, finally, to a phase characterized by chronic diseases.⁵

The early date of British growth, Britain's unique patterns of household organization, the great role played by moneyed-wage labour, and the importance of Marxian and other debates concerning modern

⁴ See, among many sources, Kuznets (1966). Obviously not all these changes have occurred in all places and it may be that in the future the patterns will not be the same as in the past. For example, in many countries tourism, rather than industry, is seen as an engine of growth.

⁵ With this has come a shift in the age-structure of mortality, with an increasing proportion of elderly among decedents. See Omran (1971).

economic growth, all make the centrality of Britain to debates on the relation of income and mortality understandable. But precisely these and other characteristics may limit the applicability of the British discussion to other nations. For example, the more limited role of state intervention in the process of economic change in Britain than elsewhere in Western Europe may mean a greater reliance on individual-level behaviour and market mechanisms than upon state-directed measures. The early onset of economic growth, which predated many scientific, technological, and medical measures, meant that there were fewer personal and public-health interventions available to Britain at any level of national income than were accessible to follower nations. And the economic growth patterns of follower nations may not resemble fully that of the leader nation, if only because that niche in the world economy had already been filled.

Lastly, the greater salience of wage labour in Britain, and the long time period covered by the historical record, have made possible the use of an independent variable—real wages—that is sometimes limiting and can be misleading. Given the lack of a fully articulated concept of national income before the 1930s, and, thus, the inability to relate income and mortality for much of the past, the widespread use of measures of real wages (nominal wage rates divided by a relevant consumer price index) is understandable. Real wage data are more generally available in the past; they go back for longer periods than incomes can be constructed; and they permit details concerning intertemporal changes that most income estimates do not. As a result, they provide incomplete measures of economic well-being for societies in which farmers represent a large proportion of the population (more typical outside of Britain). Moreover, because wages are paid to individuals, they may not provide the best possible measure of family well-being.

Clearly, then, worldwide there has been an association between economic growth and reduced mortality. Moreover, because of its leading role in the economic expansion of the modern era, arguments that may have been adequate to explain the association in Britain have often been extrapolated to explain the patterns of mortality change elsewhere. However adequate or inadequate such explanations have been in respect of the British situation, it is inappropriate to extrapolate them to other populations. For there has been a great deal of diversity among peoples, much of which contributes to changes and differences in mortality in ways that may obscure or make irrelevant the significance of the level of and changes in wages that have so dominated debates about the British pattern.

Some problems in assessing the association between income and mortality

There are various categories of reasons which explain why it might be difficult to see, at the national level, a relation between wages and mortality. We shall discuss these briefly, using both longitudinal and cross-sectional studies for our examples.

Epidemiologic

In an early study of the relationship between social status and mortality, Antonovsky (1967) argued that life expectancy of rich and poor tended to be the same in periods when epidemics and pandemics dominated the mortality regime, and that differences began to emerge only when epidemics abated. Life-expectancy patterns of the British peerage and the general population generally support this view (Hollingsworth 1964; Wrigley and Schofield 1981). For it was only in the mid-eighteenth century that the experience of the two groups diverged. This seems to have been at a time when epidemics were receding and when nutritional status, domestic arrangements, and individual hygiene began to have a relatively greater impact upon health than was the case previously (Kunitz 1983, 1987).

Another example, presented by Curtin (1989), is taken from the late nineteenth and early twentieth century experience of the British Army in India. As Table 2 indicates, officers died at higher rates than

other ranks.⁶ Unfortunately, the data are not age adjusted, and it is possible that the officers were older than the others and thus would have had higher mortality on that basis. Nonetheless, it seems plausible to argue that exposure to a new disease environment would have adversely affected the experience of all ranks about equally.

Table 2
Death rates of officers and other ranks of the British army in India, 1899–1913

Years	Average annual rate per 1,000	
	Officers	Other ranks
1899–1908	11.97	11.63
1909–1913	6.27	4.74

Source: Curtin (1989:99)

A third example is taken from a series of studies by Barker and his colleagues (Barker and Osmond 1987; Barker 1989; Barker et al. 1989), in which birth weight, weight at one year of age, and early environmental conditions have been associated with the risk of death from cerebrovascular and ischaemic heart disease, as well as other conditions during adulthood. The causal mechanisms are not at all clear and presumably involve interactions with adult diet and other factors. Whatever the mechanism, the increase in relative risk of death from ischaemic heart disease as birth weight and weight at one year decline is very impressive. If there is an association between prenatal and early childhood environment on the one hand and risk of premature death in adulthood on the other, then the temporal association between income and mortality, even when lagged by one or several years, would not necessarily be significant. This would be particularly true in open societies with a great deal of upward and downward social mobility between generations, and in eras when non-infectious diseases dominated the epidemiologic regime.

The point of this example, then, is that cohort effects of which we have very little understanding as yet may well transmit increased or decreased risks of death across generations in such a way as to weaken contemporary associations between income and mortality.

Sociologic

The social organization and culture of groups may well have an impact upon health status and the risk of death that is relatively independent of income. Our first example is taken from a contemporary prospective cohort study of the associations among social support, socioeconomic status, and mortality (Berkman and Breslow 1983:Chap. 4). The measure of social support included marital status, contacts with friends and relatives, and involvement in church and non-church groups. The data are displayed in Table 3.

Table 3
Age-adjusted mortality rates from all causes (per 1000): social network index and socioeconomic status, men and women ages 30–69, 1965–1974

⁶ Curtin (1989) has pointed to the contemporary argument that this might be explained as the result of different degrees of discipline applied to the groups.

Social network index	Socioeconomic status				
	Lower	Lower middle	Middle	Upper middle	Upper
Men					
Least connections	11.8	12.7	16.6	11.7	7.3
Most connections	8.0	11.1	6.3	8.1	4.2
Total	9.9	11.7	9.5	9.1	5.2
Women					
Least connections	9.9	7.3	8.2	6.8	5.7
Most connections	7.3	1.1	4.9	4.1	5.2
Total	8.8	4.6	6.6	5.2	5.4

Source: Berkman and Breslow (1983:137)

Several results are noteworthy. First, in general, people of high socioeconomic status had larger networks than people of low status (data not shown). Secondly, within each socioeconomic stratum, people who reported a lot of contact with others had better survival over the nine-year follow-up period than people with little contact; even controlling for health status at the outset of the study. Thirdly, there were major differences in mortality across status groups associated with the social network index. For example, upper-middle status men with low network scores had higher mortality (11.7 per 1000) than lower status men with high network scores (8.1 per 1000). Thus, depending upon the socioeconomic composition of the population and the variations in social organization within and among strata, there might or might not be an association between income and mortality.

Our second example is taken from Woodbury's (1926) classic study of infant mortality in American cities from 1911 to 1915. It was observed that while income had the expected relationship to infant mortality, there were major differences among ethnic groups that could not be explained either by income (measured as earning of the father) or by feeding practices. The data are displayed in Table 4 and indicate the following: when level of income is controlled, Jewish infants had about half the mortality rate of white native-born infants and substantially lower rates than infants of other nationalities and races as well; Italians had half the rate of Portuguese; and Germans had about the same rate as native-born whites.

Table 4
Relative mortality by nationality of mother, when influences of type of feeding and earnings of father are eliminated, 1911–1915

Colour and nationality of mother	Ratio of actual to expected deaths %			
	On basis of average rate	Eliminating feeding	Eliminating earnings	Eliminating both
Total	100.0	100.0	100.0	100.0
White	97.4	96.9	99.2	98.3
Native	84.4	80.9	95.3	88.5
Foreign-born	114.2	119.4	103.4	109.3
Italian	93.4	109.9	76.6	86.8
Jewish	48.1	55.6	48.1	49.3
French-Can.	154.0	127.9	154.9	127.6
German	92.7	94.2	92.7	97.0
Polish	141.4	169.5	118.1	149.5

Portuguese	180.1	166.5	146.9	141.1
All other	116.5	119.9	106.2	106.5
Coloured	138.8	149.3	108.4	118.4

Source: Woodbury (1926:114)

These results for Jews are not unique. Similar findings have been reported from Europe as far back as the late eighteenth century (Schmelz 1971). A variety of explanations have been offered, ranging from the attention lavished on Jewish infants by their mothers, to birth spacing, to the observation of dietary laws, and to the bactericidal effects of chicken soup. It is not clear even now what the best explanation is, but all are agreed that it is a cultural phenomenon that has been largely independent of income.

Our third example is drawn from Caldwell's (1986) study of several anomalous countries which have both low income and low mortality and thus violate the more commonly observed association between low income and high mortality. The two nations (Costa Rica and Sri Lanka) and one state (Kerala, in India) he scrutinized particularly closely, had several things in common which resulted in this remarkable accomplishment: female autonomy; considerable investment in both education and health services on Western lines, with females achieving educational levels similar to those of males; efficient, responsive health services accessible to all regardless of income; provision of either a nutritional floor or food distribution in an egalitarian fashion; and universal immunizations and intensive prenatal and postnatal care. In each case these measures derive from a history and political culture which has led to 'a broad social consensus as to the value of educational and health goals, and as to their cost, for successive governments to accept most of their adversaries' innovations instead of nullifying them' (Caldwell 1986:210).

These three examples have been meant to illustrate the fact that at the individual, ethnic-group, and national levels, cultural and social-organizational factors operating independently of income have a profound influence on mortality at all ages. Thus we see once again that non-economic factors may be of enormous significance and that, depending upon the composition and culture of the population being observed, income may have greater or lesser effects on death rates.

Geographic

Under this rubric we include the well-known differences between rural and urban mortality that prevailed until early in the present century. Table 5 displays age-adjusted death rates by occupational class for males 15 years of age and older in England and Wales in 1910-1912 at a time when the differences were still very much in evidence. Within the urban occupations there is a clear gradient of mortality by occupational status. The differences are small or non-existent between farmers and farm labourers. For our purposes, however, what is especially significant is that farm labourers have lower mortality from virtually every cause, including those not shown here, than much more highly-paid urban professional and salaried workers.

Table 5
Age-adjusted mortality rates (per 100,000) for men 15 years of age and above in England and Wales by occupational class, 1910-1912

Occupational group	Phthisis (tuberculosis)	Non- pulmonary tuberculosis	Bronchitis	Pneumonia	Diabetes	Cancer
Professional and salaried	145	14	52	71	25	126

Skilled labour	180	14	110	81	15	131
Unskilled labour	244	19	172	149	11	159
All wage earners	172	15	122	97	12	129
Farmers	61	10	55	60	20	101
Farm labourers	85	14	67	55	7	93

Source: Collins (1927:23–24)

A similar result emerges from an analysis of infant and child mortality rates in urban and rural Holland in 1877-1881 (see Table 6). The rates of death were lower among the children of the rural poor than they were among the children of the urban well-to-do.

As in our previous examples, these too suggest that the composition of the population, in this case rural-urban mix, can have a profound influence on the association between income and mortality.

Table 6
Mortality rates per 1,000 live births for children in Holland by economic status, 1877–1881

Economic status	Rates per 1,000 live births			
	Urban ^a		Rural ^b	
	< 1 year	2–5 years	< 1 year	2–5 years
Rich	93	52	110	27
Well-to-do	139	94	91	52
Less well-to-do	157	103	107	64
Poor	166	115	112	70

^aRotterdam and Dortrecht

^b40 rural communities

Source: Collins (1927:45)

Demographic

It is plausible that with advancing age, considerations other than income become increasingly important in determining the risk of death. One example of this is the so-called mortality cross-over in which the old in poor populations have lower rates of death than the old in relatively rich populations. A second example comes from a prospective cohort study in Zutphen, The Netherlands, in which men who were between 40 and 59 in 1960 were interviewed, examined, and then followed for 25 years (Duijkers et al. 1989). The men were grouped in four categories: (1) professionals, managers, and teachers; (2) small business owners; (3) non-manual workers; and (4) manual workers. Table 7 displays the all-cause mortality-risk ratios for each category using professionals, managers, and teachers as the reference group.

Table 7
Risk ratios of socioeconomic status on 25-year mortality stratified by age in a sample of men (N=856); Zutphen follow-up study

Socioeconomic status	Birth period			
	1900–1909		1910–1919	
	Risk ratio ^a	95% C.I. ^b	Risk ratio	95% C.I.
Small business owners	0.91	0.63–1.32	2.25	1.27–3.97
Non-manual workers	0.90	0.61–1.32	1.63	0.91–2.89
Manual workers	0.92	0.66–1.28	2.07	1.17–3.66

^aReference population is men in the highest social class: professional, managers and teachers.

^b95 per cent confidence interval.

Source: Duijkers et al. (1989) Table 2.

For the older men, those in their 50s in 1960, there was no difference in the risk of death from one occupational group to another. For the men who were in their 40s in 1960, there was increased risk among the owners of small businesses and among manual workers. The authors speculated

... that age is an increasingly important factor as one becomes older, even to such an extent that other factors like SES (socio-economic status) are no longer important. It is also

possible that the harmful effects related to SES play a more important role at a relatively young age. As a result the different socioeconomic groups become more and more alike as time goes by (Duijkers et al. 1989:661)

The point of this example is to suggest that the aging process itself may have consequences that over time become relatively more important than socioeconomic status. This is simply another case in which socioeconomic status is but one of several factors, and perhaps not the most significant, associated with increased or decreased risk of death.

Technologic

The association between income and mortality may be unstable because the technology of public and personal health has changed. In a cross-national study of gross national product *per capita* and life expectancy, Preston (1976) has shown that higher income is indeed correlated with greater expectation of life at birth in the 1930s just as in the 1960s, but that the shape of the relationship has changed.

The later curve appears to be steeper at incomes less than \$400 and flatter at incomes over \$600. In other words, for low income countries, a given increment in income tends to be associated with a larger gain in life expectancy in the 1960s than in the 1930s⁷ (Preston 1976:76).

And, he continues several pages later,

The relations ... appear to shift systematically during the twentieth century. In general, in order to attain a certain life expectancy between 40 and 60, a nation required an income level almost three times greater in the 1930s than in the 1960s ... The magnitude of the shifts, combined with regional income data, suggests that some 75-90 percent of the growth in life expectancy for the world as a whole over these three decades is attributable to factors exogenous to a nation's contemporary level of income (Preston 1976:83).

These exogenous factors seem to be a variety of easily exported public- and personal-health technologies.

Preston's data may be understood in two ways. First, over time at the same *per capita* income increasing levels of life expectancy have been achieved. And secondly, over time the same life expectancy can be achieved at lower *per capita* income. A similar result is observed if one considers life expectancy in Britain, Japan, and Germany in the late nineteenth and early twentieth centuries. Despite having per capita incomes considerably below those of Britain, Germany and Japan had earlier achieved comparable life expectancies. The mechanisms for this were, in Germany, public-health measures⁸, and in Japan, both public-health measures and differences in personal behaviour.⁹

These examples are meant to illustrate two points. One, that income may be less crucially related to life expectancy at some times than at others because new factors have emerged as significant in the interim. Among them have been new techniques for postponing death. Two, implicit in the comparison

⁷ See also Preston and Haines (1991).

⁸ See Evans (1987). Hamburg, being less willing to introduce public-health measures than other German cities, had a major cholera epidemic in 1892, when no other European city did. See also Brown (1988, 1989).

⁹ Hot tea, with boiling water, was safer than non-boiled water, the eating utensils differed for each individual, and there was a market for the collection of human waste for fertilizer. See Mosk and Johansson (1986); Hanley (1987); Jannetta (1987); and Johansson and Mosk (1987).

among Britain, Japan, and Germany is the trade-off between public spending and private income. Perhaps it was the greater British belief in *laissez-faire* individualism, contrasted with the elevated role of the state on the continent, that has led to a greater emphasis on individual-level factors such as real wages and *per capita* income in analyses of the changing pattern of mortality.

Economic

So far we have treated the notion of real wages as unproblematic. It is, however, highly problematic for a number of reasons. First, real wages can only be relevant in a society in which there are wages to be paid. Subsistence societies and those in which there are non-monetary exchanges may be status-ridden and divided by wealth of various sorts, but wages play no role. Moreover, status group membership may be unassociated, or inversely associated, with mortality. For example, in an as yet unpublished analysis of infant and child mortality among the matrilineal Hopi Indians of the village of Oraibi during the late nineteenth century, Levy (1990) has shown that women of prime and alternate lineages of high-status clans had both higher fertility and higher rates of child loss than other women. Prime lineages controlled most of the clan lands; alternate lineages stood ready to inherit should the prime lineage die out; other lineages, even of high-status clans, were marginal. High-status clans controlled the best lands. By the wealth criteria relevant to Hopi Indians of a century ago, the richest women had the highest rate of child loss. Levy has proposed that this is the result of attempts to assure the birth and survival of sufficient daughters to inherit the high quality land these high-status lineages controlled. The paradoxical result of high fertility was shortened birth intervals and crowding, both of which increased the risk of death.

Not only must there be wages for wages to have an effect, but the distribution of wages must be taken into account. For example, if there is a threshold effect for wages such that, once passed, very little additional mortality reduction can be expected, then if income increases throughout a society there could well be a changing relation between income and mortality. If everyone rises above the threshold, an income effect on mortality would no longer be observable. There is indeed some evidence for a threshold effect. Reviewing a study of infant mortality in Baltimore in 1915, Collins (1927) observed:

The infant mortality rate ... shows a consistent fall as income increases even above ... \$1,250. ...Data in the original report show infant mortality according to income in three classes above \$1,850, up to \$2,850 and over. But there seems to be little tendency to decrease after \$1,850. Additional income beyond a certain minimum does not seem to be associated with infant mortality (Collins 1927:50).

Put another way, unless the risk of premature death is lower among the super rich than the very rich, and the risk among the very rich is less than among the merely rich, then there must be threshold effects. No such gradient among the rich has ever been demonstrated of which we are aware.

So far we have discussed wages rather than income, for real wages have been the most frequently used measure in discussions of the standard of living and its relationship to mortality, and we have ignored the difficulties involved in estimating the real wage.¹⁰ The measurement of real wages requires estimates of nominal wages for some specific composite or subgroup of workers in some specific location, and some measure of their cost of living based on an appropriate set of prices for the particular basket of goods consumed at that particular location. Given different regional patterns of wages and of prices; the relation of age, experience, and life-cycle status to wage rates; and the existence of wage differentials by occupation and by skill level, it is not surprising that many different measures of

¹⁰ Much of the following material on the measurement of real wages is from Engerman (1990).

changes in real wages over time have appeared in the literature. Thus von Tunzelmann (1979) has provided a range of measured real-wage changes of between zero and 150 per cent for the period between 1750 and 1850.

There is also the vexing question of how real wages are to be related to even material standards of living. The nominal wage figure is for an employed individual, and could be hourly, daily, weekly, or monthly, depending upon the specific case, or it could be based on the application of a piece-wage system, directly related to output. To go from this wage rate to an estimate of annual earnings, and to family earnings, and then to a welfare equivalent requires, as has frequently been noted, a number of major adjustments. These include allowances for the extent of unemployment, for the labour effort or intensity demanded, for any disutility or utility of urban living, and for the disutility of working conditions, whether health-related or not. To go from real hourly wages to real annual earnings requires information on hours worked per day; the number of days worked over the course of the year; the valuation of any in-kind payments (particularly board and lodging); the role of other income sources, such as gifts, relief, and Poor Law payments; and aid from neighbours and kin. It is also important to know the extent to which workers held more than one job during the year, including time spent in cottage-type industries. And, to go from principal wage-earner to family incomes, it is necessary to understand the determinants of labour-force participation rates by age and gender, and the contributions to total family income of women and children.

Several additional significant problems of measurement must be considered, problems which could serve to obscure any relation between income and mortality that might exist. They affect attempts at verbal description as well as statistical analysis, since the usual analysis presumes a virtually simultaneous impact (within a short period of years) and a set of relations of a rather specific type. While alternative specifications and descriptions might be suggested, it remains uncertain as to the sensitivity of using aggregate data to capture these relations.

In some cases of disease and medical impacts, consequences occur many years after their initiating causes. For example, those survivors from cohorts that were aged 0-4 when an epidemic struck in the early nineteenth century in central Massachusetts had, many years later, lower mortality rates than did both older and younger non-stressed cohorts (Meindl and Swedlund 1977; Meindl 1982). Similarly, the study cited previously by Barker et al. (1989), indicated that the best predictor of adult heart attacks was birthweight (and, thus, maternal health). Thus the impact of the contemporary level of individual income might be offset by the importance of some influences, including incomes, much earlier in life. In addition, there may be a threshold level of income needed before which there will be an impact upon mortality or, as in the Preston studies and in the study of infant mortality described above, some level of income after which it will appear that there is no relation of income and mortality. Thus some attempts to find a continuous relation between income and mortality will be misleading; the appropriate set of measurements must allow for the existence of the particular threshold level.

There are also the difficulties posed when the full impact of any cause must allow for a cumulation of effects. No one year, by itself, may leave a dramatic effect on mortality. What may be required is the accumulation of causal factors over a period of years. Thus, for example, in a population of high enough income, one year's recession may not have any effects, whereas several years of decline will have. And, in earlier periods, the effect of a shortfall in any one year's harvest will depend upon the harvest conditions in prior years.

While statistical procedures can be devised to handle these problems, as well as such other problems as allowing for the magnitude of the secular trend, there remains some question as to whether these can fully capture the appropriate relation. In regard to the detrending of time-series data, the precise explanation for the trend behaviour (and thus for the determination of the most appropriate

statistical form) and the nature of the linking between the trend and cyclical patterns are important considerations.¹¹

Two problems raised by the foregoing discussion of real wages merit somewhat more elaboration: aggregation from local to national levels, and the role of the state not only in providing services but in redistributing both income and food in times of want. We shall deal with each briefly.

Aggregation. There is a long tradition of studies of the relationship between income, wages, and social class on the one hand and mortality and health status on the other, several of which we have already cited. Historically most of these have been cross-sectional and at the local level. The temptation, however, is often to extrapolate from these locally or temporally restricted data to the national level, with results that may well be misleading. For example, Hobsbawm (1957), in his now classic contribution to the standard-of-living debate, asserted that mortality fell from the 1780s to the 1820s and then rose until the 1840s. This assertion seems to have been based on local studies, for aggregate data of the national level, which were not available to Hobsbawm in 1957, do not bear it out.¹² This suggests that even if any relationship existed between wages and mortality among the working class featured in the standard-of-living debate, such a trend may not be generalized to the entire population. Local conditions were sufficiently diverse that one could not adequately extrapolate to the national level without very broad coverage indeed. In the absence of such coverage of both income and mortality, generalizations would be either impossible or questionable.

Government intervention. In his paper on the changing relationship between social class and life expectancy, Antonovsky (1967) suggested that the convergence of the life expectancy of the rich and poor in this century has been due largely to the emergence of welfare states. We suggest that the very emergence of the nation-state itself in the eighteenth century had the effect of dampening fluctuation in mortality from both epidemics and famine. This was the result of actions which only a reasonably effective bureaucracy could engage in successfully: quarantine, the control of armies on their territory, and the relief of local famines by shifting food from regions of surplus to those of want. Indeed, writing at the end of the eighteenth century, Malthus was one of the first to observe that mortality rates were declining, and to relate the decline to changes in personal and public behaviour.

I think it appears that in modern Europe the positive checks to population prevail less and the preventive checks more than in past times, and in the more uncivilized parts of the world.

War, the predominant check to the population of savage nations, has certainly abated even including the late unhappy revolutionary contests; and since the prevalence of a greater degree of personal cleanliness, of better modes of clearing and building towns, and of a more equitable distribution of the products of the soil from improving knowledge in political economy, plagues, violent diseases, and famines have been certainly mitigated, and have become less frequent (Malthus 1960:Vol. 1:315).

He was not alone. Contemporary continental mercantilist writers such as J. P. Frank and successors such as Chadwick in Britain, Villerme in France and Virchow in Germany recognized that mortality was not exogenous but the result of social arrangements which could be modified by personal and public behaviour.¹³ Such behaviour must have diminished the sensitivity of mortality to

¹¹ See the debate discussed in Brenner (1977) and Kasl (1979).

¹² See Wrigley and Schofield (1981:414) and Deane and Cole (1962:127).

¹³ See, for example, Rosen (1958); Stangeland (1966); and Coleman (1982).

fluctuation in wages and income, though it is difficult to provide adequate historical data in support of such an assertion.

India at the start of the present century, however, provides an example of the impact of changing public policy on mortality. The development of a railroad network and the enhanced desire of the British to provide an effective relief system, including the use of the transport system to move grain into regions of potential famine, led to a dramatic decline in famine-related mortality, as well as declines in average death rates after the start of the twentieth century. Indeed, McAlpin (1983:218), argues that the one major famine in India after the first decade of the twentieth century, in 1943-44, can be attributed to the wartime destruction of the transport system and the shift in government concerns with World War II.¹⁴

Clearly, then, the ability and willingness of governments to intervene in what would otherwise have been calamitous conditions has attenuated the responsiveness of mortality to fluctuations in income. This has been true, not only in welfare states in the twentieth century, but in earlier centuries as well.

The point we have wanted to make in this section is that, broadly speaking, there are two classes of reasons why there is no secular association between mortality and real wages. The first has to do with the fact that mortality rates are the product of many different forces, not only wages, and it is a mistake to attempt to capture them all under the rubric of economic status. The second has to do with the fact that, even accepting the very real importance of wages, there are profound difficulties and heroic assumptions that must be made when reconstructing a wage series to relate to trends in mortality. This leads us to our final topic, which has to do with ways of thinking about wages and income as causes of death.

Thinking about the association between income and mortality

Considering this litany of problems, what is surprising is not that there is no very impressive temporal association between real wages and mortality, but that anyone ever expected there would be. Mortality rates and life expectancy are the final common pathways of numerous factors, including but not limited to wages and income. The fact that within any particular population at any particular moment the rich are likely to do better than the poor is not to be wondered at. The rich, after all, are better able than the poor to clothe, feed, and house themselves (although, also, whether out of perversity or of ignorance, sometimes better able to indulge in behaviour damaging to their health). This ability to better clothe, feed, and house themselves is why, within the appropriately chosen groups, income is generally but not always inversely related to risk of death, and why, all things considered it is better to be rich than poor.

For example, Table 6 shows a tendency for infant and child mortality rates to increase with decreasing economic status within the urban and rural populations (with an anomalous observation among rich rural residents), even though between urban and rural residents of the same classes mortality rates differ substantially. That the association between socioeconomic status and mortality is not invariably monotonic, however, is illustrated in Table 3. The highest class invariably has lower mortality than the lowest class, regardless of social network score. In the middle ranks, however, the pattern is far from clear, even when holding constant the social network score.

Given the facts that economic status is not always monotonically associated with mortality risk, and that numerous factors other than wages and income influence mortality, are there ways of usefully conceiving of the relationship between wealth and mortality? The expectation of a monotonic relationship between the two is analogous to the sometimes accurate but generally oversimplified

¹⁴ See also Sen (1981).

association between specific micro-organisms and the onset of specific diseases. Just as for some preventative and treatment purposes it is reasonable to consider only the micro-organism and its host, that is, when immunizing children or when treating certain infections with antibiotics, so for some purposes it is useful to consider only the association between wealth and mortality. On the other hand, just as truly adequate understanding of particular diseases requires an understanding of the full ecological setting, including sociocultural, microbiological, and pathophysiological factors, so does the full understanding of mortality more broadly involve consideration of income or wealth as but one of many factors which influence the risk of death in any particular setting.

Inevitably this kind of understanding involves local knowledge of a highly detailed and complex nature which is often at odds with a strong desire that many of us also feel to achieve a more universal, elegantly simple understanding at a very general level. Usually it is the latter kind of knowledge which is considered science. The former is thought of as too particularistic to deserve such a label. Without getting into the debate about what is and what is not science, it should be clear that both kinds of knowledge are of value. It is important and useful to be able to make generalizations across societies. It is equally important to be able to point to the many deviant cases that force us to question the validity of the generalizations we sometimes make with such facility, and often so facilely.

These observations suggest that the association between wages and mortality is not entirely similar to that between an essential nutrient and a deficiency disease. Which is to say, death is not caused by the lowering of wages in the same way that pellagra is caused by the absence of nicotinic acid. Stated so baldly, the assertion seems obvious. It is not. Implicitly that is the assumption underlying the question with which we began.

Conclusion

It seems general that, over the past several centuries, both within and among societies, the rich, on average, have had lower mortality rates than the poor. It appears that at some stage the differentials widened, but in the twentieth century there has tended to be some reduction without, however, yet achieving complete equality. Within this general pattern, however, there remain deviant cases. In some instances, a trade-off between the effects of individual income and social measures, such as public health, makes income a less than perfect predictor of mortality; in others individual differences in cultural and other aspects of behaviour mean that different mortality rates are experienced at similar levels of individual income. In addition the changing importance of different diseases—the shift from infectious to non-infectious diseases—would confound any relationship.

Clearly, for most nations sometime in the past three centuries, there have been increases in *per capita* income and reductions in the level of mortality. At a gross level, therefore, these changes are obviously associated. Nevertheless, the fluctuations in each do not follow a systematic pattern nor, for reasons discussed above, should we have expected that to have been the case. Since mortality has always been influenced by so many factors, including income, it would not be expected that any simple one-to-one relation within a limited time span could be found. Moreover, given the dramatic changes in the distribution of incomes, occupations, educational levels, and so on, that occur with the process of economic growth, any study at the level of national aggregates would mean combining groups with possibly quite divergent experiences.

Whatever the relation of income and mortality posited within and among nations cross-sectionally, the temporal association of national income and mortality rates has had many fewer adherents; and most of these seem to have been in the English-speaking world. More speculatively, it might be asked why this assumed relationship has been of more salience in Britain and its overseas extensions than it seems to have been elsewhere. Focusing on real wages and *per capita* incomes in the analysis of mortality reductions appears to reflect the same political culture that is associated with the developmental policies

that the English-speaking world has generally followed; that is, an emphasis on the growth of individual income as the most effective way to improve the quantity and quality of life. Historically, as suggested above, other societies have followed other paths to a similar demographic outcome.

References

- Antonovsky, A. 1967. Social class, life expectancy and overall mortality. *Milbank Memorial Fund Quarterly* 45:31–73.
- Barker, D.J.P. 1989. Rise and fall of western diseases. *Nature* 338:371–372.
- Barker, D.J.P. and C. Osmond. 1987. Inequalities in health in Britain: specific explanations in three Lancashire towns. *British Medical Journal* 294:749–752.
- Barker, D.J.P., C. Osmond, P.D. Winter, B. Margetts and S.J. Simmonds. 1989. Weight in infancy and death from ischaemic heart disease. *The Lancet* September 9:577–580.
- Berkman, L.F. and L. Breslow. 1983. *Health and Ways of Living: The Alameda County Study*. New York: Oxford University Press.
- Brenner, M.H. 1977. Health costs and benefits of economic policy. *International Journal of Health Services* 7:581–623.
- Brown, J.C. 1988. Public reform for private gain? Public health and sanitary infrastructure in German cities, 1877–1910. Paper presented at the annual meeting of the Social Science History Association, Chicago.
- Brown, J.C. 1989. Public health reform and the decline of urban mortality: the case of Germany, 1876–1912. Paper presented at the annual meeting of the Population Association of America, Baltimore.
- Caldwell, J.C. 1986. Routes to low mortality in poor countries. *Population and Development Review* 12:171–220.
- Coleman, W. 1982. *Death is a Social Disease: Public Health and Political Economy in Early Industrial France*. Madison: University of Wisconsin Press.
- Collins, S.D. 1927. *Economic Status and Health: A Review and Study of the Relevant Morbidity and Mortality Data*, Public Health Bulletin No. 165, September, 1926, Treasury Department, US Public Health Service. Washington DC: US Government Printing Office.
- Crafts, N.F.R. 1985. *British Economic Growth During the Industrial Revolution*. New York: Oxford University Press.
- Curtin, P.D. 1989. *Death by Migration: Europe's Encounter with the Tropical World in the Nineteenth Century*. Cambridge: Cambridge University Press.
- Deane, P. and W.A. Cole. 1962. *British Economic Growth, 1688-1959*. New York: Cambridge University Press.
- Duijkers, T.J., D. Kromhout, I.P. Spruit and G. Doornbos. 1989. Inter-mediating risk factors in the relation between socioeconomic status and 25-year mortality (The Zutphen Study). *International Journal of Epidemiology* 18:658–662.
- Engerman, S.L. 1990. Reflections on the 'standard of living debate': new arguments and evidence. Paper presented at the Conference on Capitalism and Social Progress (The Hartwell Symposium), University of Virginia, Charlottesville.
- Evans, R.J. 1987. *Death in Hamburg*. New York: Oxford University Press.
- Flinn, M. 1981. *The European Demographic System, 1500-1820*. Brighton: Harvester.
- Fogel, R.W. 1986. Nutrition and the decline in mortality since 1700: some preliminary findings. Pp. 439–527 in *Long-Term Factors in American Economic Growth*, eds. S.L. Engerman and R.E. Gallman. Chicago: University of Chicago Press.
- Gwatkin, D.R. 1980. Indications of change in developing country mortality trends: the end of an era? *Population and Development Review* 6:615–644.
- Hanley, S.B. 1987. Urban sanitation in preindustrial Japan. *Journal of Interdisciplinary History* 18:1–16.
- Hobsbawm, E.J. 1957. The British standard of living, 1790-1850. *Economic History Review* 10:45–68.
- Hollingsworth, T.H. 1964. The demography of the British peerage. *Population Studies* 18:supplement.
- Jannetta, A.B. 1987. *Epidemics and Mortality in Early Japan*. Princeton: Princeton University Press.

- Johansson, S.R. and C. Mosk. 1987. Exposure, resistance and life expectancy: disease and death during the economic development of Japan, 1900-1960. *Population Studies* 41:207-235.
- Kasl, S.V. 1979. Mortality and the business cycle: some questions about research strategies when utilizing macro-social and ecological data. *American Journal of Public Health* 69:784-788.
- Kunitz, S.J. 1983. Speculations on the European mortality decline. *Economic History Review* 36:349-364.
- Kunitz, S.J. 1987. Making a long story short: a note on men's height and mortality in Britain from the first through the nineteenth centuries. *Medical History* 31:269-280.
- Kuznets, S. 1966. *Modern Economic Growth: Rate, Structure, and Spread*. New Haven: Yale University Press.
- Levy, J.E. 1990. The demographic consequences of social stratification in an 'egalitarian' society. Paper presented at the annual meeting of the American Anthropological Association, New Orleans.
- Livi-Bacci, M. 1990. *Population and Nutrition: An Essay on European Demographic History*. New York: Cambridge University Press.
- Malthus, T.R. 1960 (first published 1803). *Essay on the Principle of Population*, 2nd ed., 2 vols. London: J.M. Dent.
- Mathews, R.C.O., C.H. Feinstein and J.C. Odling-Smee. 1982. *British Economic Growth, 1856-1973*. Stanford: Stanford University Press.
- McAlpin, M.B. 1983. *Subject to Famine: Food Crises and Economic Change in Western India, 1860-1920*. Princeton: Princeton University Press.
- Meindl, R.S. 1982. Components of longevity: developmental and genetic responses to differential childhood mortality. *Social Science and Medicine* 16:165-174.
- Meindl, R.S. and A.C. Swedlund. 1977. Secular trends in mortality in the Connecticut Valley, 1700-1850. *Human Biology* 49:389-414.
- Mosk, C. and S.R. Johansson. 1986. Income and mortality: evidence from modern Japan. *Population and Development Review* 12:415-440.
- Omran, A.R. 1971. The epidemiologic transition: a theory of the epidemiology of population change. *Milbank Memorial Fund Quarterly* 49:509-538.
- Pope, C. 1992. Adult mortality in America before 1900: a view from family histories. Pp. 267-296 in *Strategic Factors in Nineteenth-Century American Economic History*, eds. C. Goldin and H. Rockoff. Chicago: University of Chicago Press.
- Preston, S.H. 1976. *Mortality Patterns in National Populations: With Special Reference to Recorded Causes of Death*. New York: Academic Press.
- Preston, S.H. and M.R. Haines. 1991. *Fatal Years: Child Mortality in Late Nineteenth-Century America*. Princeton: Princeton University Press.
- Rosen, G. 1958. *A History of Public Health*. New York: MD Publications.
- Schmelz, U.O. 1971. *Infant and Early Childhood Mortality among the Jews of the Diaspora*. Jerusalem: The Institute of Contemporary Jewry, The Hebrew University of Jerusalem.
- Sen, A. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Clarendon Press.
- Stangeland, C.E. 1966 (first published 1904). *Pre-Malthusian Doctrines of Population: A Study in the History of Economic Theory*. New York: Augustus Kelley.
- Stolnitz, G. 1955. A century of international mortality trends: I. *Population Studies* 9:24-55.
- United Nations, Department of Economic and Social Affairs. 1971. *The World Population Situation in 1970*. ST/SOA/SER.A/49. New York.
- United Nations, Department of Economic and Social Affairs. 1973. *The Determinants and Consequences of Population Trends* 2 vols. ST/SOA/SER.A/50. New York.
- Von Tunzelmann, G.N. 1979. Trends in real wages, 1750-1850, revisited. *Economic History Review* 32:33-49.
- Woodbury, R.M. 1926. *Infant Mortality and its Causes*. Baltimore: The Williams and Wilkins Company.
- World Bank 1990. *World Development Report, 1990*. New York: Oxford University Press.

Wrigley, E.A. and R.S. Schofield. 1981. *The Population History of Britain 1541-1871: A Reconstruction*. London: Edward Arnold.