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## Sources of income, wealth and the length of life: An individual level study of mortality

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### Abstract

The relationship between income and mortality is explored by examining mortality in each income decile and income source (from earnings, government or capital). Swedish individual level income data was analysed for approximately 6.5 million adults. The quality of our data is unprecedented for this type of study, in terms of size and completeness of population coverage and death registration. The results suggest that inequalities in mortality are marked even in Sweden, one of the affluent countries where the effects of health inequalities are assumed to be lowest worldwide. The only income source that was associated with beneficial outcomes for all population groups was earnings. Welfare payments, often associated with illness, are associated with higher mortality, particularly for men. Capital income (our 'wealth' indicator) generally reduces the risk of mortality but increases the risk for some younger groups.

**Keywords:** *Income, wealth, mortality, individual data, Sweden*

### Introduction

In this paper we explore the extent to which there is an association between income and mortality in all sectors of the population of a country with a strong welfare state and secondly we consider whether income source has any salience in that relationship. This paper presents an initial investigation of a very large, rich and unique database which permits more far-reaching conclusions than previously published on this topic. The aim of this investigation is to promote thought and further research rather than to provide definitive answers.

The association between income and health has been extensively investigated across a range of countries and at a variety of geographic scales both within, and between countries (Ecob & Davey Smith, 1999; Kaplan, Pamuk, Lynch, Cohen, & Balfour, 1996; Lynch, 2000; Lynch, Davey Smith, Kaplan, & House, 2000; Lynch et al., 2004;

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Ram, 2006; Ross *et al.*, 2000; Wilkinson & Pickett, 2006). Collectively, these studies point towards a direct relationship between income and mortality or morbidity and some towards income inequality also being directly implicated (most strongly at the level of the nation state). The risk for premature mortality tends to increase as income level declines. In the UK, for example, it has been estimated that a quarter of all premature deaths can be linked to poor socio-economic circumstances resulting primarily from receiving low incomes (Davey Smith, Dorling, Mitchell, & Shaw, 2002). Thus there is overwhelming evidence that low income is a key contributory factor to premature poor health.

In this study we attempt to deepen our understanding of this relationship between income and mortality in two ways. Firstly, we look at the extent to which there is the same relationship between income and mortality for all ages and the extent to which the relationship remains even for men and women in a country with a strong redistributive welfare state. Secondly, we consider the mechanisms by which the relationship between income and mortality may occur through an exploration of the role of income source. The problem of health inequalities is by its very nature a national problem in that it is the comparison of the health of different groups in the same population that highlights the inequalities. That is why we feel that analysis of a national data set which includes the whole population is one particularly appropriate way of addressing the problem of health inequalities (especially given that the nation state is found to be the key level at which other relevant trends are observed (Wilkinson & Pickett, 2006)). We are able to do this here through analysis of a data set unprecedented in terms of its size and depth.

A major advantage of the Swedish data set used in our study is that individual, non-aggregated, data on income and income source is available for the whole population. Most income studies, although not all, are carried out at some degree of aggregation, such as a census or postcode area because of data availability, or to overcome confidentiality issues. Analysing individual data ensures we do not suffer from the ecological fallacy which concerns applying results from an area to specific individuals within the area. We can compare people of the same ages and groups of the same sizes. Additionally we do not have problems of a stratified sample so we do not have to use a multilevel approach or weightings which makes the analysis much easier to interpret. Furthermore we do not have to generalise our results to the rest of the population using, for example, confidence intervals, because our results are those of the whole population.

By not acknowledging any multilevel structure, however, we have not avoided the atomistic fallacy since we treat individuals as individuals, as if they do not share the income of those they live with or are related to, when in reality this is an important process operating at the household or family level. This may mean that our results may be more pertinent for men than women as women are more likely not to be the highest income earner and more likely to work fewer hours (even in Sweden). Introducing a household level of analysis would probably be beyond the computational abilities of most multilevel software packages with such a large data set and a large number of subgroups in the analysis. This study is an exploratory study. Other levels of complexity can be considered for future work.

The Swedish individual longitudinal population registers can be linked to each other to provide information on health and mortality together with socio-demographic characteristics such as age, sex and socio-economic status for every member of the population. We do that here suspecting that different income levels and sources are likely to have very different meanings at different points in people's lives according to both their

age and sex. This may provide clues on how income, its level and the nature of its source, is related to mortality.

In using rich sources of individual income data from Sweden, coupled with accurate and complete population and death certificate registers, we benefit from highly reliable data sources examining large numbers of individuals. As the data are derived from Swedish government taxation sources we are reassured of their high quality in terms of reliability, validity and completeness. This makes this data set suitable for secondary analysis. Accurate income data are generally hard to obtain in most countries because individuals often consider income to be a private matter.

*Nature of the relationship between income and mortality in the Swedish context*

The welfare state provides a mechanism by which part of the significance and the extent of low income can be reduced. In an ideal world the welfare state should prevent low income being associated with poor health. Sweden, which has one of the most redistributive welfare states in the world, has comparatively little income inequality as measured by the Gini coefficient (Lynch, Davey Smith, Hillemeier, Shaw, Raghunathan, 2001) and higher life expectancy than would be expected from its GDP per person (Lynch et al., 2000). The relationship between socio-economic position and mortality in Sweden has been found to be weak when compared to other countries (Whitehead, Diderichsen, & Burström, 2000).

However, the welfare state in Sweden has been under pressure, as in the rest of the world (Davey Smith et al., 2002; Schallick, Hadden, Pamuk, Navarro, & Pappas 2000), in recent years. Moreover, Sweden experienced a serious recession in the early 1990s, a situation where the welfare state often comes under threat. When the Swedish economy recovered, towards the end of the 1990s, the gap between rich and poor within Sweden increased considerably (Gustafsson & Palmer, 2002). There were more people with very high incomes but also more experiencing general financial vulnerability. Financial vulnerability increased for various reasons: The higher use of temporary employment contracts, the large influx of refugees that Sweden accepted but placed near the bottom of its social scale during this difficult financial time and, thirdly, due to changes in the welfare system made in the recession. Generally benefit levels were cut and qualification for benefits became more exacting. Furthermore, there was a change in emphasis so that selective benefits became more common than universal benefits. Thus those on benefits became more distinguished from the rest of society. The final report of the 'Welfare Commission' in October 2001 concluded that some of the most vulnerable groups became particularly disadvantaged by the changes in welfare: Single mothers, recent immigrants and young adults (Bergmark & Palme, 2003).

Despite this, hospitalisations, overall mortality and infant mortality continued to decline throughout the 1990s, although mental illness rates did increase. Thus it does appear that the Swedish welfare state was able to mitigate the effects of the recession to some extent. However, these national measures of mortality may mask disproportionate increases in some groups or there may be a time lag before mortality rates change (Bergmark & Palme, 2003). Furthermore, as those on benefits have become more differentiated from the rest of society, having benefits as a source of income may be more stigmatising in Sweden now than it was there in the past. Thus source of income may be important for mortality.

We cannot, and do not, claim that results of Swedish data analysis can be easily extrapolated to the rest of the world. The nature of the relationship between income and

mortality is already known to differ between countries. In Finland the relationship between income and mortality has been found to be linear and in the United States convex curvilinear (Martikainen, Makela, Koskinen, & Valkonen, 2001). This was thought to reflect the Finnish welfare state providing better life chances for the poor compared to the situation in the United States. A convex curvilinear relationship suggests that low income is such a major determinant of health because even a small increase in income makes a major difference to the health of the poorest. The linear relationship in Finland implies, according to the authors of that study, that the welfare state somewhat mitigates people experiencing poverty. It still implies also, of course, that income is still the key driver of health inequalities. In this study we consider the nature of the relationship in Sweden, another country with a well-developed welfare state, albeit in a slightly different way because the quality of the data means we can examine whether the nature of the relationship is different for men and women from different age groups in each income decile.

### *Income source*

Although a link between income and health has been clearly established, the mechanisms through which low income increases a person's risk of dying still elude us. There are two major interpretations (Lynch et al., 2000): firstly, the neo-material interpretation (also known as the absolute income hypothesis) and, secondly, the psychosocial environment interpretation (the relative income hypothesis). The former suggests that the health problems of people with low income stem from reduced access to goods and services such as education, health, transportation, healthy food, good quality housing and working conditions. The latter suggests that poor health is due largely to psychological processes producing stress from being of low social status or relatively deprived, when compared to others (Wilkinson, 1994). It is not simply that the quantity of income appears to be related to mortality, but rather that disparities between different groups (income inequality) play an important additional role, in rich nations possibly now the major role, in determining sub-group population mortality rates.

To mitigate the lack of material resources researchers advocate improving the services aimed at the poor. To reduce the psychosocial stress of being low status, it is sometimes suggested that social trust and social capital should also be developed to lessen the status differences within society or their effects (Lynch et al., 2000). At the start of the twenty-first century, it appeared that much of the available evidence gives more credibility to the neo-material interpretation than the psychosocial interpretation (Deaton, 2002; Lynch et al., 2000; Wagstaff & van Doorslaer, 2000) and thus to reduce inequalities in health, inequalities in income must be reduced. However, a recent Swedish study (Åberg Yngwe, Fritzell, Lundberg, Diderichsen, & Burström, 2003) using data from 1991 to 1997 on 27,000 individuals found that relatively deprived men, compared to reference groups, were more likely to self-report poor health. Thus the aforementioned relative deprivation hypothesis was postulated to be a mechanism in the relationship between income and health. It has also been claimed most recently that affluent groups within unequal nations fair worse than affluent group in more equal rich nations (Wilkinson & Pickett, 2007) — further complicating the debate.

As the overall debate becomes more complex it may be a mistake to differentiate the two interpretations: In a society with low social capital, the rich and poor will be less and less likely to have the same interests; thus a government policy of providing opportunities and services for the poor will be unlikely to be supported (Porta, Borrell, & Copete, 2002). Therefore a negative psychosocial environment is likely to occur hand in hand with

a negative material environment for the poor. Furthermore, policy initiatives to raise social capital without first reducing income inequalities may not be accepted by the general population. Two approaches to explore further how income and mortality are related are discussed next in this paper: First we consider the nature of the relationship for each income decile and second, the relevance of the source of income is examined.

As well as providing reliable and complete data on income received by individuals, the Swedish government tax authority also collects detailed information on income source. This provides the opportunity to ask questions such as whether earned income is better than unearned income or whether receiving one's money from the state may appear to mean less (possibly be less psychologically fulfilling) than receiving it via an employee's payslip or from a shareholder's dividend (as the psychosocial interpretation would suggest), or whether the consumer's source of income is irrelevant (the neo-materialist interpretation). If source of income is relevant then it may be especially important that those benefits that are provided through a welfare state are provided in the form of tax credits or negative income tax, or are universal rather than means tested, so as not to carry the stigma of being hand-outs.

Previous work does suggest that income source is important. In an American psychology experiment, students and home owners were asked to rate potential neighbours (Kirby, 1999). Income source (work, work and public assistance, work and an inheritance) was found to be more important grounds for discrimination than race. Income sources that provide good lifetime social circumstances, such as wealth (Menchik, 1993), family assets (Mare, 1990), lifetime earnings (Wolfson, Rowe, Gentleman, & Tomiak, 1993) and occupational careers (Hart, Davey Smith, Blane, Gillis, & Hawthorne, 1995), appear to be especially beneficial. However, reverse causality can be an issue: Consistent good health can provide the wherewithal to acquire income from such sources rather than income from these sources being the reason for good health (Michaud & van Soest, 2004). Our total Swedish population data set means that we can consider the impact of income source in detail by disaggregating age and sex groups and include a short temporal lag between time of income measurement and time of health outcome observation to partly help mitigate the possible selective bias of poor health resulting in declining income.

In summary, our study is original in that we aim to use population data to do two things: Firstly we consider the extent to which there is a relationship between income and mortality in a country with a strong redistributive welfare state, and secondly we explore whether there is a link between source of income and mortality. A link between source of income and mortality would provide support for a psychosocial mechanism between income and health whereas if income source makes little difference this study provides evidence more supportive of the absolute income hypothesis. However, as we say above, this is a rapidly evolving field of study and it is likely that an initially complex synthesis of these competing theories will soon emerge.

## Data and methods

Data were obtained from Statistiska Centralbyrån (SCB), the official Swedish government statistics agency. We used extracts from 'Louise', an individual, longitudinal SCB database, created from a variety of registers concerning population, education, income and occupation. In this present study, the total population, and income and capital registers were used. *Louise* contains for each adult, an annual specification of



income from different sources such as different types of employment, self-employment, studies, illness, unemployment benefit, parental leave, rehabilitation, pension, social allowances and capital. Information is drawn from the employer's statements of earnings, bank interest, stock dividends and tax declarations. The *Louise* data were linked to the *Swedish death certificate* register to determine which individuals had died during the study period. Linkage was made possible due to the comprehensive use of unique personal identifiers in Sweden.

We used data on 6.5 million adults (aged 20 and above) over 4 years, from 1996 to 1999, totalling 26 million individual tax records. During this period there were 372,171 deaths (an average of approximately 93,000 per year). Of the 6,576,950 adults living in Sweden in 1999, we excluded 73,991 people (1.1%) from the analysis who did not have complete income data, of whom 293 (0.4%) died within the study period.

We attempted to minimise the impact of reverse causation, namely that ill-health leading to death reduces income immediately prior to death, by taking income data from 1995, the earliest year for which we had income data for all adults, rather than the year prior to death. In our data, we have relatively precise individual income, subdivided by type as detailed in Table I. Although the declared income data are likely to be accurate, we acknowledge that it is difficult to estimate the contribution of unofficial, illegal or undeclared sources of income in this study.

Those individuals (largely self-employed) reporting a tax loss are problematic as far as recorded income is concerned. We had no explicit way to identify those individuals incorporating a tax loss in their reported earnings; however, we tried to minimise the effect of this by zeroing negative reported incomes (or losses). We have no additional data on individuals who reduced their tax burden through reporting a (partial) tax deduction. An alternative would have been to remove these individuals from the analysis; however, we wished to keep all adults in the analysis, since a major strength of our work was to analyse the whole population of a nation-state.

There are five broad categories of income recorded in the registers as shown in Table I. Note that sickness benefit and parental leave in Sweden is paid from central government rather than from the employer (and we include parental leave entitlement with earnings). Capital income is well recorded in Sweden: consisting of the aggregate of interest from bank savings, stocks and shares dividends, income from property letting, lottery winnings and profit from the sale of property, businesses, etc., and includes foreign as well as Swedish-sourced income. Clearly the capital income source is an indicator not only of income, but also of longer-term wealth including inheritance.

All analysis was carried out in SAS (SAS Institute Inc., 2003). Mortality rates per 10,000 people were calculated for each single year of age (20–100+) and sex combination. Note that we are not treating age as a confounding variable but rather we

Table I. Income data sources.

Source	Explanation
Sickness benefit	Sickness benefit
Welfare	Social (income) support and unemployment benefit
Pension	Early retirement and retirement pensions
Earnings	Income from employment, own company and parental leave
Capital	Income from capital, shares and property

are comparing people of the same ages, since we do not wish to remove the age effect but conversely are specifically interested in the nature of the relationships as age (and sex) change. Those aged 20 and 21 were excluded from the analysis as mortality rates were too low and the numbers receiving very low incomes too high (many were probably still living at home as students).

For analysis by income source, larger five-year age groups were used. In this analysis we compared the composition of the income of the dead population with that of the general population for each age/sex combination (by composition of income we mean the amount of income that came from each income source). Thus we did not assign individuals to a single (or predominant) source since individuals often had income from more than one source. Instead we averaged each source for each age/sex combination and compared the dead to the total population. We calculated the relative ratio of mortality for income from each source, where a relative ratio of 1.0 indicates no elevated or reduced risk of dying when comparing the deceased population to the total population. A higher relative ratio meant that people with most of their income from that source were more likely to die, where, for example, a relative ratio of 2.0 meant twice the risk of people of that five-year age group, as compared to others in the same income decile and of the same sex. Naturally the relative importance of these income sources will interact: They are not independent of each other.

## Results

### *Income deciles investigation*

As a starting point, Figure 1 shows the distribution of mortality by single year of age and sex to confirm the reliability of (and clear regularities in) the data. This distribution mirrors that observed worldwide in developed countries.

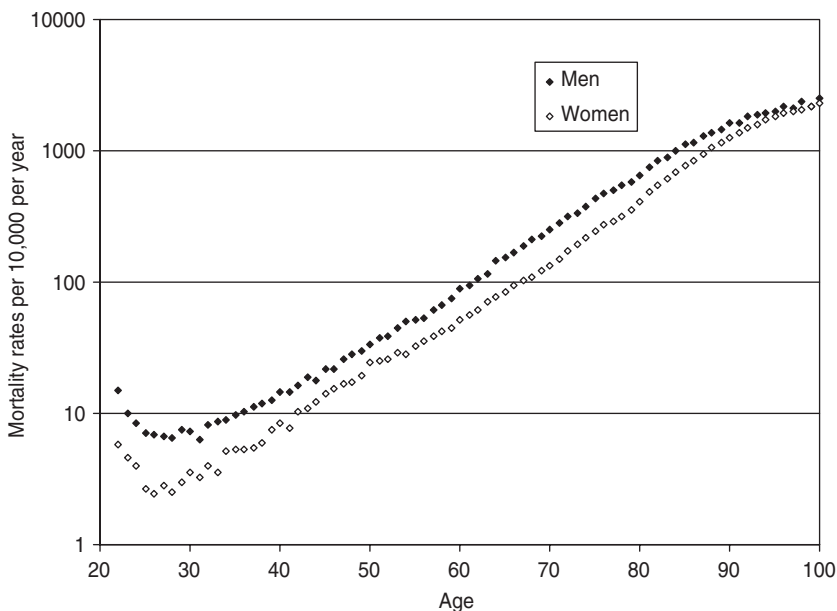


Figure 1. Mortality rate for men and women 1996–99 by age per 10,000 (log scale).



Tables II and III show extracts, firstly of the raw death count by sex, age and total income decile, and then secondly of the mortality rates by sex, age and total income decile. Figures 2 and 3 illustrate these tables, showing the mortality rates for men and women separately by income decile, for each single year of age, between the ages of 22 and 100. We draw the reader's attention in Figures 2 and 3 to the stark differences between the poorest and richest deciles.

Investigating the direct relationships at an individual level, in Sweden, there is a clear and robust relationship between levels of income and mortality. Inequality between income deciles is particularly striking for the three poorest deciles between the ages of 35 and 65 and is distinguishable until the age of 90. The mortality rate amongst poorer Swedish men reaches 10 per 10,000 at age 30 but only reaches 10 per 10,000 at about age 45 for the richer deciles. These findings can be straightforwardly illustrated: At the income extremes, a 45-year-old income rich man (top decile) has the same chances of dying a year as a poor man aged 30 (bottom income decile). Similarly a 35-year-old women earning twice the median income has the expected annual mortality risk of a 21-year-old woman earning the median income.

The difference between the poorer deciles and the intermediate deciles is more marked than that between the richest deciles and the intermediate deciles. Thus although the poorest have a clear disadvantage regarding mortality, the richest do not have such a clear advantage over those of median income. For most of the Swedish adult population income is clearly linked to mortality. Being poor around age 30 has the effect of 'aging' a man by 15 years when compared to life chances for the richest decile. Our detailed data set also allowed exceptions to the general rule that additional income is beneficial to be identified.

Table II. Death count by age and sex within each total income decile group (extracts).

Sex	Age	Total	Poorest decile	2nd	3rd	4th	5th	6th	7th	8th	9th	Richest decile
M	22	83	8	6	7	1	6	11	12	6	9	17
M	30	179	21	28	42	21	8	12	12	8	8	19
M	40	348	34	98	55	30	22	29	16	27	24	13
M	50	864	166	175	114	73	49	65	52	53	69	48
M	60	1625	246	322	253	138	118	121	127	91	99	110
M	70	3676	535	496	435	433	402	363	306	263	231	212
M	80	6882	882	839	795	717	666	632	626	615	543	567
M	90	4489	579	583	556	461	408	414	387	371	356	374
M	100+	423	31	56	43	43	45	39	44	38	43	41
F	22	31	5	1	1	3	0	1	4	11	2	3
F	30	84	1	12	22	6	7	6	10	5	7	8
F	40	193	16	41	29	15	14	13	10	12	19	24
F	50	618	100	101	56	51	40	38	48	38	53	93
F	60	936	140	145	110	78	73	67	70	85	73	95
F	70	2232	270	310	214	241	260	228	226	173	186	124
F	80	6042	712	646	717	661	585	609	596	539	518	459
F	90	7724	765	813	833	891	818	832	779	703	636	654
F	100+	1844	146	187	220	183	196	176	179	192	193	172

Notes: Sex: M= male, F= female; Age: For that **single** year group shown; Total: Number of deaths in study period to that **single** age year group of that sex; Poorest decile: number of deaths occurring to those individuals receiving the poorest decile of income for people of that age and sex; 2nd, 3rd, 4th ... Richest: Counts of deaths of subsequent decile groups of the population. Along each row all numbers would be near equal (with random fluctuation) were incomes to be independent of mortality.

### Further discussion of income deciles and mortality

In this section we explore the variation and anomalies that occur for certain groups including older people, young adults, women and those reporting the lowest income.

At very old ages, income has less influence. Survival may be the result of other processes: Generally those who are to die through causes strongly related to their lack of

Table III. Mortality rates by age and sex within each total income decile group (rates per 10,000 per year) (extracts).

Sex	Age	Av.	Poorest decile	2nd	3rd	4th	5th	6th	7th	8th	9th	Richest decile
M	22	15	14	11	12	2	11	20	22	11	16	30
M	30	7	9	11	17	9	3	5	5	3	3	8
M	40	15	14	42	23	13	9	12	7	11	10	6
M	50	33	64	68	44	28	19	25	20	20	27	19
M	60	88	133	174	137	75	64	65	69	49	54	60
M	70	252	367	340	296	298	277	248	210	181	158	146
M	80	647	827	789	746	673	626	592	592	577	511	534
M	90	1610	2066	2096	1984	1656	1468	1486	1385	1335	1278	1342
M	100+	2485	1813	2872	2925	2515	2647	2321	2558	2235	2560	2412
F	22	6	9	2	2	6	0	2	7	21	4	6
F	30	4	0	5	9	3	3	3	4	2	3	3
F	40	9	7	18	13	7	6	6	4	5	8	11
F	50	24	39	40	22	20	16	15	19	15	21	37
F	60	51	71	85	60	43	40	36	38	46	40	52
F	70	134	162	187	128	145	156	137	136	104	112	75
F	80	408	478	434	484	447	396	410	402	364	350	310
F	90	1254	1238	1309	1303	1514	1322	1348	1269	1146	1036	1063
F	100+	2329	1774	2413	2638	2437	2519	2214	2277	2421	2434	2180

Notes: Sex: M=male, F=female; Age: For that **single** year group shown; Av.: Number of deaths in study period to that single age year group of that sex per 10,000 people per year; Poorest decile: Number of deaths occurring to those individuals receiving the poorest decile of income per 10,000 people of that age and sex per year; 2nd, 3rd, 4th . . . Richest: Rates of deaths of subsequent decile groups of the population. Along each row all numbers would be near equal (with random fluctuation) were incomes to be independent of mortality.

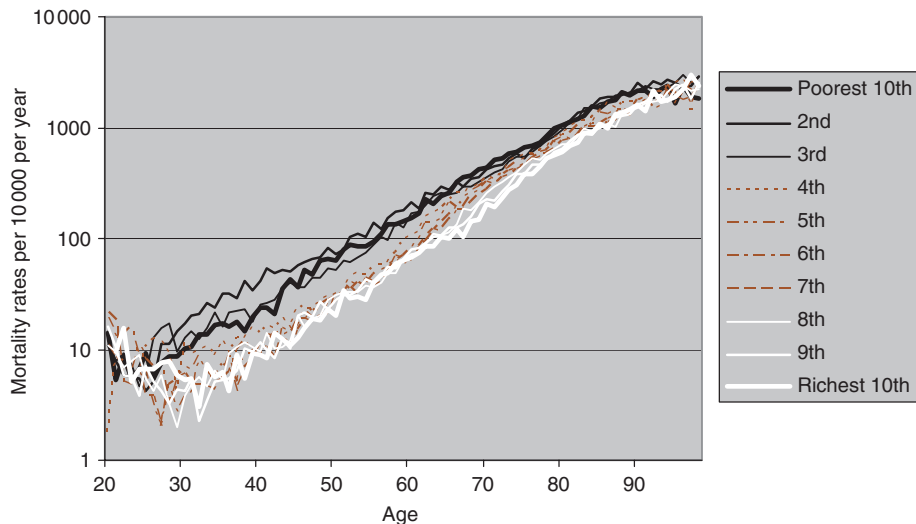


Figure 2. Mortality rate for men 1996–99 by age per 10,000 by total income deciles (log scale).

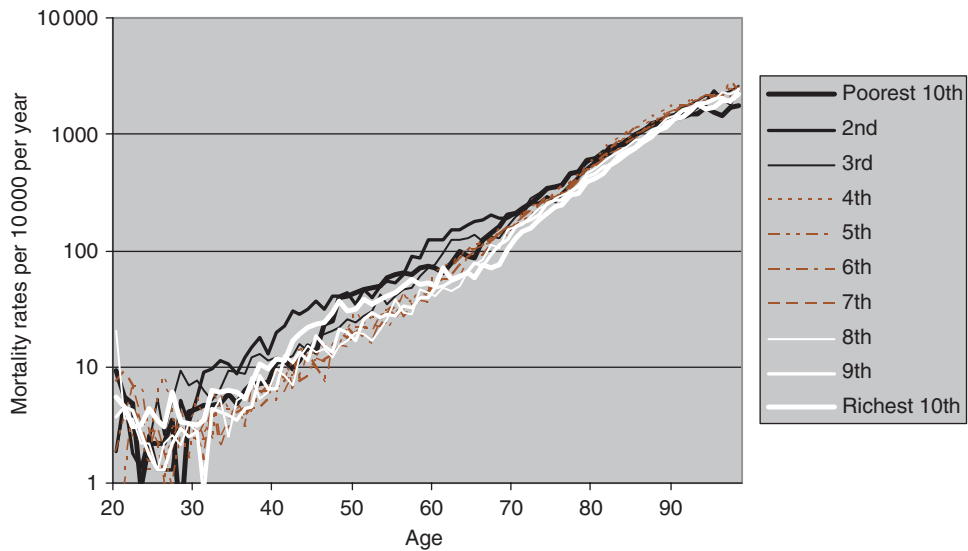


Figure 3. Mortality rate for women 1996–99 by age per 10,000 by total income deciles (log scale).

income, or from more intermediate causes related to low income (most obviously, worldwide, smoking) are already dead by this point. Below the age of 30 there is no clear pattern by income, interestingly it is the richest tenth who have the highest mortality rate at a very young age. Twenty-two-year-old men in the richest decile experienced 21% of all mortality for men aged 22, an excess of 110% over the expected mortality. Over half of all these deaths involved car, bike or boating accidents. Other causes of death were suicides, drowning and injury involving animals. Only one death occurred from disease. The high proportion of activity (rather than illness) related deaths, although amongst a small population group, is striking.

For women, mortality is less clearly differentiated by income (Figure 3). From the age of 30 until 80, women in one of the three bottom deciles have the highest mortality. However, from the ages of 35 to 60, women in the highest income decile have the second or third highest mortality rates. Such women in their 40s are more likely to die than those in the poorest quintile. Note that this is personal income rather than household income and so we cannot conclude that the women in the highest individual income decile are those with the most resources available to them. Investigating total household income might be more revealing in this instance.

For both sexes the poorest decile generally did not experience the highest mortality. This may be an indication firstly of unofficial or undeclared sources of income contributing to reduced mortality risk, or secondly (and very similarly) owners of a company reporting a tax 'loss': more an accounting device than a true representation of individual income. We tried to minimise the effect of the latter explanation by zeroing negative reported incomes (or losses) but this is not totally satisfactory. Naturally, in Swedish society an actual zero income should not occur because of the welfare system. What this analysis cannot consider is non-monetary benefits or benefits-in-kind, such as free childcare, or subsidised meals. One would assume that without these benefits, the inequalities revealed in the analysis would be greater.

Thus we have established that in Sweden low individual income is clearly linked to raised mortality risk and that this is particularly marked in younger adult and midlife — the productive years when the majority of the population are working. Despite concerns on the use of individual income for women we have demonstrated inequality for women as well as men.

### *Source of income*

Now that we have established within Sweden that income is an important factor for mortality for most age and sex groups we can complement our analysis with a focus on source of income. In Tables IV and V, illustrated in Figures 4 and 5, relative ratios below one indicate a protective effect from that income source, with ratios over one indicating a detrimental effect. For example, in Figure 4, males in aggregate aged 20–24 who died, had, on average, 7.0 times sickness benefit, 1.7 times welfare benefit, 8.4 times pension, 1.1 times capital interest but 0.9 times average earnings when compared to the alive population in the same age and sex group.

Earned income reduces the risk for mortality. Pensions and sickness benefits are associated with a high risk for mortality particularly for younger people. Welfare benefits slightly increases the risk of mortality for men but not for women. Welfare payments make up a greater proportion of the income of men in the poorest deciles (analysis not reported). Thus it is the association between welfare and low income, not welfare *per se* that is most important. Men who receive a high proportion of their income from earnings, but whose income is still low, appear to suffer similarly. Interest from holding capital income (our 'wealth' indicator) generally reduces the risk of mortality but increases the risk for mortality for young men and women in their early 30s. The relationship between income source and mortality weakens as people age.

Table IV. Five-year age group mortality ratios for the 5 income sources (males).

Age band	Sickness	Welfare	Earnings	Pension	Capital interest
20–24	6.99	1.65	0.92	8.36	1.05
25–29	6.40	1.50	0.72	11.63	1.23
30–34	6.04	1.49	0.62	9.92	0.67
35–39	4.62	1.51	0.58	9.69	0.79
40–44	4.10	1.49	0.60	7.18	0.84
45–49	3.88	1.64	0.61	5.31	0.57
50–54	3.37	1.42	0.65	4.20	0.66
55–59	2.64	1.29	0.63	3.18	0.67
60–64	1.75	0.91	0.59	1.96	0.73
65–69	0.96	0.54	0.46	1.16	0.57
70–74	0.38	0.67	0.43	0.91	0.76
75–79	0.85	1.05	0.37	0.93	0.80
80–84	1.21	0.78		0.92	0.90
85–89	0.24	0.80		0.92	0.91
90–94	0.35	0.72		0.94	0.95
95–99		0.33		0.97	0.93
100+		0.89		1.03	0.73

Note: Sickness, welfare, earnings, pensions and capital interest: Ratios under 1 indicate a protective effect, over 1 a detrimental effect from that income source, for each age band.

Table V. Five year age group mortality ratios for the 5 income sources (Females).

Age band	Sickness	Welfare	Earnings	Pension	Capital interest
20–24	10.73	1.16	0.78	14.35	0.61
25–29	6.24	1.20	0.94	15.49	0.79
30–34	5.13	1.08	0.82	13.19	1.64
35–39	4.91	1.21	0.77	9.10	0.91
40–44	4.86	1.12	0.76	6.29	1.11
45–49	4.27	1.05	0.80	4.21	0.69
50–54	3.72	0.96	0.75	3.29	0.91
55–59	2.91	1.00	0.73	2.64	0.92
60–64	2.05	0.82	0.65	1.86	0.82
65–69	0.97	0.59	0.45	1.21	0.69
70–74	0.13	0.85	0.37	0.94	0.78
75–79	0.64	0.94	0.33	0.95	0.84
80–84	0.43	0.94		0.94	1.00
85–89		0.82		0.95	0.94
90–94		0.75		0.98	1.00
95–99		0.87		0.99	0.97
100+		0.57		1.01	0.99

Note: Sickness, welfare, earnings, pensions and capital interest: Ratios under 1 indicate a protective effect, over 1 a detrimental effect from that income source, for each age band.

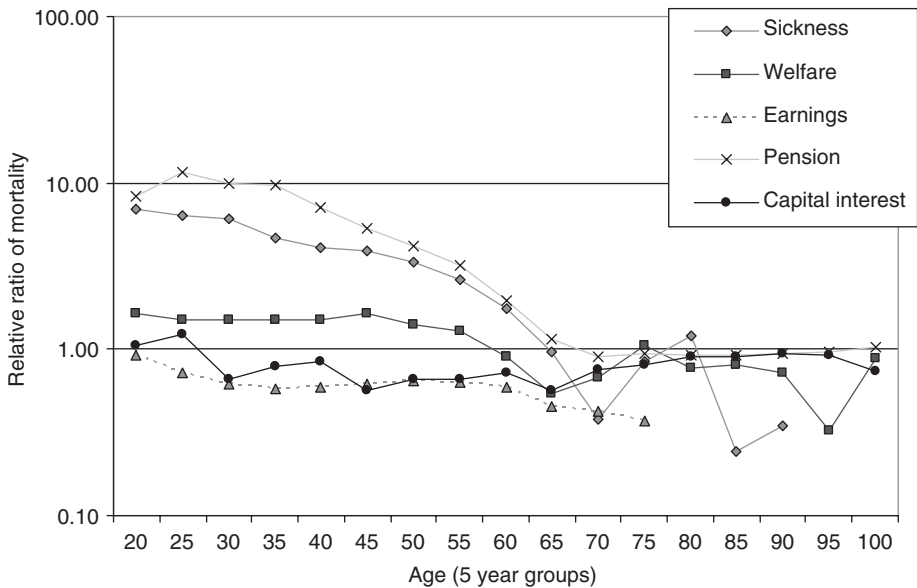


Figure 4. The relative ratio of dying by income source by five-year age groups for men (log scale).

Further discussion of income source

Little previous work has considered income source, especially in the way presented here, thus some of the findings merit further discussion. Many studies have considered economic status and unemployment and so we can use their findings as a guide to interpreting part of what we see in this study to be the trends by income source. The following questions are considered: Firstly why pensions as well as sickness benefits

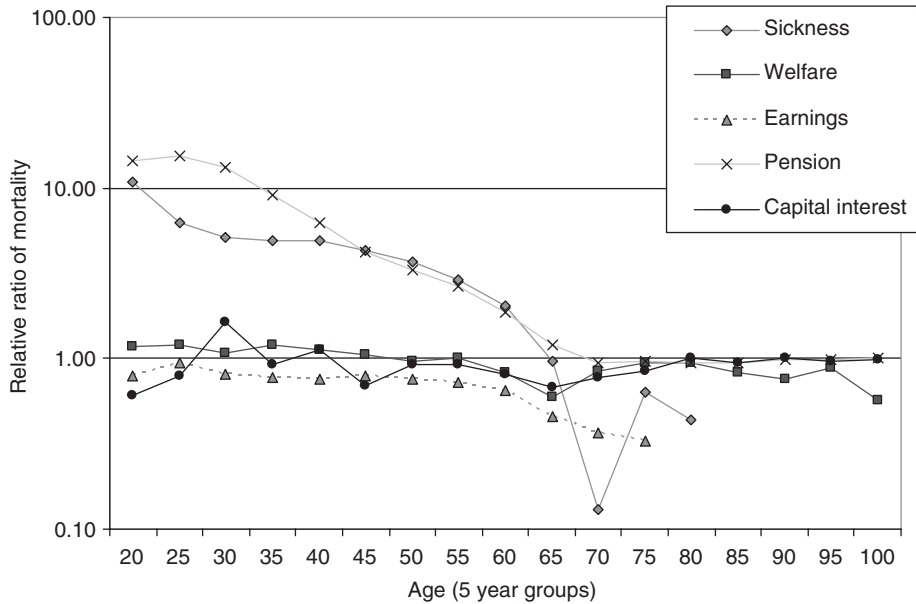


Figure 5. The relative ratio of dying by income source by five-year age groups for women (log scale).

are such strong predictors of mortality; secondly why welfare payments have different associations with mortality risk for men and women; thirdly why earned income appears to be so beneficial (and particularly for people who have passed the statutory retirement age); and finally why holding substantial wealth (such that an income is earned through interest from it) is not always beneficial. Definitive answers are beyond the scope of this paper; here we simply draw attention to some salient issues.

Until the age of 65, receipt of a pension or sickness benefit indicates a high relative risk for mortality (over a ten fold higher risk for those under age 35). Both sources are indicators of ill health pre-retirement in Sweden, where, due to a recent reclassification, an early pension is invariably drawn due to poor health unlike elsewhere, for example the UK, where early retirement is more often for leisure purposes and enabled by affluence. This must be taken into account when noting the very high risks for those with pensions under 40.

For men, income from welfare increased the risk of dying until the age of 60. For women there was not a clear pattern. This might imply that being on welfare has — on average — a different meaning for men and women (Statistics Sweden, 2004) and of course general social and health trends in Sweden and Scandinavia need to be born in mind (Åberg Yngwe et al., 2003; Andersson, 2000; Bergmark & Palme, 2003; Gustafsson & Palmer, 2002; Keskimäki 2003; Martikainen et al., 2001). Women are much more likely to be living on welfare payments if they do not have a partner, especially if they have small children rather than because they are sick. Reverse causality may also be an issue: Long-term welfare receivers, in particular, may not be earning due to addiction or psycho-social health problems, which also increase the chances of dying.

Earned income had a protective effect for all ages and sexes. As an example, a 35-year-old woman earning twice the median income has the expected mortality rate of a 21-year-old woman earning the median income. Her income, in effect, is associated with



her having the same life expectancy as a woman 14 years younger on a median income. Work may have a protective effect through psychosocial mechanisms such as providing meaning, increased control, self-esteem and social networks. On the other hand, not working may increase feelings of shame, incompetence and disconnectedness from the rest of society and make available more time to engage in risky activities (even, perhaps especially, for the very rich who do not have to work and who can live on capital incomes alone). Naturally, just as pensions and sick pay are markers for poor health, being in a position to work is a marker for good health.

We found that earned income is most beneficial to 75-year-old men and 70-year-old women (but not older). If you can retire late — but not too late — it is protective against mortality; however, studies conducted in the UK have found that earned income at older age groups is not good for mortality (Dorling & Gunnell, 2003). Possibly the welfare state in Sweden means that older people work for positive benefits rather than as a necessity as happens elsewhere. If this is the case it has wide-ranging and interesting implications as worldwide the 1940s baby boom cohort approaches imminent mass retirement and the mid-1960s cohort begins to contemplate the possibility of early retirement (if only mainly amongst the richer social groups in only more affluent countries). In a country with a well thought out welfare system, such as Sweden, working later in life can be a choice, not a necessity and so can be beneficial.

It might be expected that capital income, or wealth, would always have a protective effect because it provides extra income without effort and presumably, wealth indicates long-term financial security. However, for young men and women up to their early 30s it appeared to have the reverse effect, albeit slight. Why should high capital income be linked with higher mortality? Although the absolute numbers are small, the trends suggest a difference in cause of death, as previously alluded to, amongst the most well off younger age categories, towards riskier lifestyles. Thus are the risky lifestyles of the young and rich distorting mortality statistics? Men who died aged 25–29 received 2.3 times more unearned income compared to men with the same total income of the same age. For these young people capital income is likely to be inherited rather than self-produced. Indeed a small minority of women in their 30s may similarly be benefiting from their husband's capital income rather than their own. Thus in a society where the welfare state reduces the importance of one's own sources of income, being in the highest income decile may be hazardous to health at a young age and in middle age for women due to the mechanisms that place people in that income bracket.

## Conclusions, policy implications and limitations

In this paper we have made use of individual level data to explore how income is linked to mortality. The first issue was to examine the nature of the relationship between income deciles and mortality in Sweden. We find that, despite redistributive welfare policies, there is a strong relationship between income and health between the ages of 35 and 65 for men and a weaker link between the ages of 30 and 80 for women. The poorest deciles are disadvantaged more than the richest deciles are advantaged. Thus a more redistributive policy, even in Sweden, would be beneficial overall for longevity. Our findings give weight to fiscal policy initiatives that attempt to redistribute income to reduce premature mortality further. These results confirm previous findings from ecological studies.

The second issue addressed was the implications of source of income for mortality. Our main finding was that all sources of income, other than earned income, could in some circumstances be prejudicial to longevity. This may explain why there is still such a strong relationship between income and mortality in a country with a strong welfare state — even though the poor receive benefits from the welfare state to cover their material needs their income source is less beneficial than if they were working (or could work, or if benefits were partly received through paying lower or negative taxes associated with some earned income). Providing valued activities for all citizens should be a priority for the Swedish government in addition to looking after material needs. This provides some support for the psychosocial hypothesis. All sources of income were not equal in their benefits to health as the neomaterialist hypothesis would suggest. However, the psychosocial hypothesis would imply that wealth, as well as earned income, would be beneficial and never detrimental.

Empirical results from much previous literature would also suggest that higher wealth would be beneficial to health. In general this was the case. However, young people receiving high capital income (our wealth indicator) were at a higher risk of mortality. Wealth does not equal happiness (Clark & Oswald, 2002; Hartog & Oosterbeek, 1998; Jencks, 2002; Layard, 2005; Lear, 1988; Oswald, 1997; Smith, 1759)! Were the state to tax wealth and redistribute it to young people in greater need, the health effects of that money would, of course, be not only generally positive but far greater in aggregate effect for everyone — not just the poor. In this way our study may help explain partly why very recent new work suggests that the rich also suffer where there is inequality.

Furthermore, it is known that the lifestyles of at least the moderately wealthy tend to be at least partly adopted by the poor a generation later (Mitchell, Dorling, & Shaw, 2000). If this were to occur in the future then there could be an increase in the prevalence of relatively high mortality rates of currently experienced by affluent young Swedes with more time for recreation than the population as a whole. Thus an action that can be taken now to curtail the excesses of the rich may be beneficial in the future — even in a country with relative inequalities as low as in Sweden.

There are limitations to our study. We must stress that the descriptive analysis presented here simply explores the nature of the relationships between income (of various types) and mortality risks, but crucially cannot identify causal mechanisms. We can only simply point towards areas worthy of further investigation in this regard and show that there almost certainly must be very strong biological mechanisms being prompted, mediated or repressed through factors associated closely with these social inequities.

We are aware of ill health contributing to, or influencing income. We took income data from 1995, examining individuals who died from 1996 to 1999. Ideally we would have liked to have examined income data from earlier in an individual's life or total lifetime earnings, but unfortunately we only had access to income data from 1995 onwards. A further limitation concerns the relationship between individual and household income. Our results suggest that this may be particularly pertinent for women. We only examined individual income; however, there is strong evidence to suggest that an individual's risk of mortality can be mitigated by access to household income or indeed wider family income and wealth resources.

Of course this is our first investigation of one of the richest health and income data sets available. In future it should be possible to investigate, for example, the higher mortality among young people and richer middle-aged women in more depth. The context of individuals' lives is increasingly found to be of importance: the relationship between income and health has been found to be related to geography and

ethnicity (Barnett, Moon, & Kearns 2004) among many other factors, and for each cause of death a complex social, economic and biological story can be told. In Sweden, in common with other countries, the polarisation of the benefit dependents from the rest of the population has been coupled with increased residential segregation by income and ethnicity (Andersson, 2000). Further work might usefully examine local geographical differences using, for example, multilevel modelling techniques. Associated to this is investigating the psychological effect of (high or low) relative income when compared to a neighbourhood norm. We are also keen to investigate the possible effect on overall life-expectancies assuming all the population in the future were to adopt the health status of the most wealthy decile, with consequential potential benefits to older parts of society (and potential future harm to the young).

Obviously the generalisability of these findings depends on the extent to which the Swedish evidence can be extrapolated to other countries, cultures and contexts. We have found the same general patterns as observed in a large number of less comprehensive or aggregated studies from other countries (Daly, Duncan, Kaplan, & Lynch, 1998; Deaton, 2002; Deaton & Paxson, 2001; Fiscella & Franks, 1997, 2000; Hart et al., 1995; Judge, 1995; Judge, Mulligan, & Benzeval, 1998; Kirby, 1999; Lynch et al., 2001; Lynch, Harper, & Davey Smith, 2003; Mare, 1990; Mellor & Milyo, 2000, 2001; Menchik, 1993; Porta et al., 2002; Schalick et al., 2000; Wagstaff & van Doorslaer, 2000; Whitehead et al., 2000; Wilkinson, 1994; Wolfson et al., 1993) which provides reassurance. Our finding that income is still so relevant to health in one of the most equal countries in the world is an indicator that this issue is potentially of even greater consequence in the more inequitable countries for which such data is not so readily available.

### Summary

Given high-quality individual level national population data, one can produce easily interpretable statistics to illustrate how income level is closely related to mortality rate and how access to income reduces premature mortality levels. When income was disaggregated by source, what is counted as earned income was found to be most protective and wealth (measured through capital sourced income) appeared to be damaging at young ages (especially for men) but protective at older ages. Analysing full population tax linked individual data, rather than the results of self-completed voluntary social surveys, reveals an extent of inequalities in mortality which are unlikely to be an artefact of method.

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### References

- Åberg Yngwe, M., Fritzell, J., Lundberg, O., Diderichsen, F., & Burström, B. (2003). Exploring relative deprivation: Is social comparison a mechanism in the relation between income and health. *Social Science & Medicine*, 57, 1463–1473.

- Andersson, R. (2000). Etnisk och socioekonomisk segregation i Sverige 1990–1998. *Arbetsmarknad, demografi och segregation* (SOU 37: 223–266). Stockholm: Fritzes Offentliga Publikationer.
- Barnett, R., Moon, G., & Kearns, R. A. (2004). Social inequality and ethnic differences in smoking in New Zealand. *Social Science & Medicine*, 59, 129–143.
- Bergmark, A., & Palme, J. (2003). Welfare and the unemployment crisis: Sweden in the 1990s. *International Journal of Social Welfare*, 12(2), 108–122.
- Clark, A., & Oswald, A. (2002). A simple statistical method for measuring how life events affect happiness. *International Journal of Epidemiology*, 31(6), 1139–1144.
- Daly, M. C., Duncan, G. J., Kaplan, G. A., & Lynch, J. W. (1998). Macro-to-micro links in the relation between income inequality and mortality. *Millbank Quarterly*, 76(3), 315–339.
- Davey Smith, G., Dorling, D., Mitchell, R., & Shaw, M. (2002). Health inequalities in Britain: Continuing increases up to the end of the 20th century. *Journal of Epidemiology and Community Health*, 56(6), 434–435.
- Deaton, A. (2002). Commentary: The convoluted story of international studies of inequality and health. *International Journal of Epidemiology*, 31, 546–549.
- Deaton, A., & Paxson, C. (2001). Mortality, income and income inequality over time in Britain and the United States. National Bureau of Economic Research: Working paper 8534.
- Dorling, D., & Gunnell, D. (2003). Suicide: The spatial and social components of despair in Britain 1980–2000. *Transactions of the Institute of British Geographers*, 28(3), 442–460.
- Ecob, R., & Davey Smith, G. (1999). Income and health: What is the nature of the relationship? *Social Science & Medicine*, 48, 693–705.
- Fiscella, K., & Franks, P. (1997). Poverty or income inequality as predictor of mortality: Longitudinal cohort study. *British Medical Journal*, 314, 1724–1727.
- Fiscella, K., & Franks, P. (2000). Individual income, income inequality, health and mortality: What are the relationships? *Health Services Research*, 35(1), 307–318.
- Gustafsson, B., & Palmer, E. (2002). Was the burden of the deep Swedish recession equally shared? *Review of Income and Wealth*, 48(4), 537–560.
- Hart, C., Davey Smith, G., Blane, D., Gillis, C., & Hawthorne, V. (1995). Social mobility, health and cardiovascular mortality. *Journal of Epidemiology and Community Health*, 49, 552–553.
- Hartog, J., & Oosterbeek, H. (1998). Health, wealth and happiness. Why pursue a higher education? *Economics of Education Review*, 17(3), 245–256.
- Jencks, C. (2002). Does inequality matter? *Daedalus*, Winter 2002, 49–65.
- Judge, K. (1995). Income distribution and life expectancy: A critical appraisal. *British Medical Journal*, 311, 1282–1285.
- Judge, K., Mulligan, J.-A., & Benzeval, M. (1998). Income inequality and population health. *Social Science & Medicine*, 46(4–5), 567–579.
- Kaplan, G. A., Pamuk, E. R., Lynch, J. W., Cohen, R. D., & Balfour, J. L. (1996). Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. *British Medical Journal*, 312(7037), 999–1003.
- Keskimäki, I. (2003). How did Finland's economic recession in the early 1990s affect socio-economic equity in the use of hospital care? *Social Science & Medicine*, 56, 1517–1530.
- Kirby, B. J. (1999). Income source and race effects on new-neighbor evaluations. *Journal of Applied Social Psychology*, 29(7), 1497–1511.
- Layard, R. (2005). *Happiness: Lessons from a new science*. London: Allen Lane.
- Lear, J. (1988). *Aristotle: The desire to understand*. Cambridge, UK: Cambridge University Press.
- Lynch, J. (2000). Income inequality and health: Expanding the debate. *Social Science & Medicine*, 51(7), 1001–1005.
- Lynch, J., Davey Smith, G., Harper, S., Hillemeier, M., Ross, N., Kaplan, G. A., et al. (2004). Is income inequality a determinant of population health? Part 1. A Systematic review. *Millbank Quarterly*, 82, 5–99.
- Lynch, J., Davey Smith, G., Hillemeier, M., Shaw, M., Raghunathan, T., & Kaplan, G. (2001). Income inequality, the psychosocial environment, and health: Comparisons of wealthy nations. *Lancet*, 358(9277), 194–200.
- Lynch, J. W., Davey Smith, G., Kaplan, G. A., & House, J. S. (2000). Income inequality and mortality: Importance to health of individual income, psychosocial environment, or material conditions. *British Medical Journal*, 320, 1200–1204.
- Lynch, J. W., Harper, S., & Davey Smith, G. (2003). Commentary: Plugging leaks and repelling boarders—where to next for the SS Income Inequality? *International Journal of Epidemiology*, 32, 1029–1036.
- Mare, R. D. (1990). Socioeconomic careers and differential mortality among older men in the US. In J. Vallin, S. D' Souza & A. Palloni (Eds.), *Measurement and analysis of mortality: New approaches* (pp. 362–387). Oxford: Clarendon Press.
- Martikainen, P., Makela, P., Koskinen, S., & Valkonen, T. (2001). Income differences in mortality: A register-based follow-up study of three million men and women. *International Journal of Epidemiology*, 30(6), 1397–1405.
- Mellor, J. M., & Milyo, J. (2000). *Income inequality and health status in the United States: Evidence from the current population survey*. Princeton, NJ: Robert Wood Johnson Foundation.

- Mellor, J. M., & Milyo, J. (2001). Reexamining the evidence of an ecological association between income inequality and health. *Journal of Health Politics Policy and Law*, 26(3), 487–522.
- Menchik, P. L. (1993). Economic status as a determinant of mortality among black and white older men: Does poverty kill? *Population Studies*, 47, 427–436.
- Michaud, P. C., & van Soest, A. H. O. (2004). Health and wealth of elderly couples: Causality tests using dynamic panel data. Tilburg University, Centre for Economic Research.
- Mitchell, R., Dorling, D., & Shaw, M. (2000). *Inequalities in life and death: What if Britain were more equal?*. Bristol: The Policy Press.
- Oswald, A. J. (1997). Happiness and economic performance. *Economic Journal*, 107, 1815–1831.
- Porta, M., Borrell, C., & Copete, J. (2002). Commentary: Theory in the fabric of evidence on the health effects of inequalities in income distribution. *International Journal of Epidemiology*, 31, 543–546.
- Ram, R. (2006). Further examination of the cross-country association between income inequality and population health. *Social Science & Medicine*, 62, 779–791.
- Ross, N. A., Wolfson, M. C., Dunn, J. R., Berthelot, J.-M., Kaplan, G. A., & Lynch, J. W. (2000). Relation between income inequality and mortality in Canada and in the United States: Cross sectional assessment using census data and vital statistics. *British Medical Journal*, 320(7239), 898–902.
- SAS Institute Inc (2003). *SAS System*. NC, USA: Cary.
- Schalick, L., Hadden, W., Pamuk, E., Navarro, V., & Pappas, G. (2000). The widening gap in death rates among income groups in the United States from 1967 to 1986. *International Journal of Health Services*, 30(1), 13–26.
- Smith, A. (1759). *The theory of the moral sentiments*. Indianapolis: Liberty Classics (Reprint 1952).
- Statistics Sweden (2004). Women and Men in Sweden. Facts and Figures 2004. Stockholm, Sweden: 62.
- Wagstaff, A., & van Doorslaer, E. (2000). Income inequality and health: What does the literature tell us? *Annual Review of Public Health*, 21, 543–567.
- Whitehead, M., Diderichsen, F., & Burström, B. (2000). Researching the impact of public policy on inequalities in health. In H. Graham (Ed.), *Understanding health inequalities*. Buckingham: Open University Press.
- Wilkinson, R. G. (1994). *Unfair shares*. Ilford: Barnardo's.
- Wilkinson, R. G., & Pickett, K. E. (2006). Income inequality and population health: A review and explanation of the evidence. *Social Science & Medicine*, 62(7), 1768–1784.
- Wilkinson, R. G., & Pickett, K. E. (2007). Income inequality and social gradients in mortality. *American Journal of Public Health*, forthcoming.
- Wolfson, M., Rowe, G., Gentleman, J. F., & Tomiak, M. (1993). Career earnings and death: A longitudinal analysis of older Canadian men. *Journals of Gerontology, Series B, Psychological Sciences and Social Sciences*, 48, S167–179.