BMJ

RESEARCH

Inequalities in premature mortality in Britain: observational study from 1921 to 2007

Bethan Thomas, research fellow,[1] Danny Dorling, professor of human geography,[1] George Davey Smith, professor of clinical epidemiology[2]

[1]Social and Spatial Inequalities Group, Department of Geography, University of Sheffield, Sheffield S10 2TN

[2]Department of Social Medicine, University of Bristol, Bristol BS8 2BN

Correspondence to: B Thomas
B.S.Thomas@sheffield.ac.uk

Cite this as: *BMJ* 2010;341:c3639
doi:10.1136/bmj.c3639

ABSTRACT

Objective To report on the extent of inequality in premature mortality as measured between geographical areas in Britain.

Design Observational study of routinely collected mortality data and public records. Population subdivided by age, sex, and geographical area (parliamentary constituencies from 1991 to2007, pre-1974 local authorities over a longer time span).

Setting Great Britain.

Participants Entire population aged under 75 from 1990 to 2007, and entire population aged under 65 in the periods 1921-39, 1950-3, 1959-63, 1969-73, and 1981-2007.

Main outcome measure Relative index of inequality (RII) and ratios of inequality in age-sex standardised mortality ratios under ages 75 and 65. The relative index of inequality is the relative rate of mortality for the hypothetically worst-off compared with the hypothetically best-off person in the population, assuming a linear association between socioeconomic position and risk of mortality. The ratio of inequality is the ratio of the standardised mortality ratio of the most deprived 10% to the least deprived 10%.

Results When measured by the relative index of inequality, geographical inequalities in age-sex standardised rates of mortality below age 75 have increased every two years from 1990-1 to 2006-7 without exception. Over this period the relative index of inequality increased from 1.61 (95% confidence interval 1.52 to 1.69) in 1990-1 to 2.14 (2.02 to 2.27) in 2006-7. Simple ratios indicated a brief period around 2001 when a small reduction in inequality was recorded, but this was quickly reversed and inequalities up to the age of 75 have now reached the highest levels reported since at least 1990. Similarly, inequalities in mortality ratios under the age of 65 improved slightly in the early years of this century but the latest figures surpass the most extreme previously reported. Comparison of crudely age-sex standardised rates for those below age 65 from historical records showed that geographical inequalities in mortality are higher in the most recent decade than in any similar time period for which records are available since at least 1921.

Conclusions Inequalities in premature mortality between areas of Britain continued to rise steadily during the first decade of the 21st century. The last time in the long economic record that inequalities were almost as high was in the lead up to the economic crash of 1929 and the economic depression of the 1930s. The economic crash of 2008 might precede even greater inequalities in mortality between areas in Britain.

INTRODUCTION

Inequalities in mortality in Britain have persisted over many years. Recent government interventions have aimed to reduce these inequalities but, the evidence suggests, to little effect. The report of the independent inquiry into inequalities in health (Acheson Report)[1] reviewed the situation of health inequalities as they then stood a decade ago and identified policy areas that could enable the government to act to reduce such health inequalities. Several interim progress reports were published by the Department of Health, with a major review published in May 2009.[2] In early 2010 the latest Marmot review was published.[3] It begins with a misquotation from the poet Pablo Neruda: "Rise up with me against the organisation of misery." Although the review contains much useful new evidence and a careful description of the current state of knowledge, its recommendations perhaps fail to live up to its epigram. A particular focus of the review is reflected in its suggestion that: "If society wishes to have a healthy population, working until 68 years, it is essential to take action to both raise the general level of health and flatten the social gradient." Despite government interventions, inequalities in health have not diminished; indeed in some cases the gap might have widened over the past 10 years, reflecting widening inequality in wealth and income over this period. Evidence is currently difficult to interpret, however, as targets have been changing, as have geographical areas for which data are reported.[4] We have therefore extended our previous research on trends in socioeconomic differentials in mortality in Britain,[5] recalculated standardised mortality ratios for the 1990s in the light of revised population estimates, and carried forward the series to 2007. We have also analysed the longer historical trajectory of mortality inequalities from the 1920s to the present day. The data we present are analysed at the geographical level, with areas

Table 1 | Age and sex standardised mortality ratios (SMRs) and relative index of inequality* (RII) for age 0-74 according to tenth of poverty, 1990-2007

	1990-1	1992-3	1994-5	1996-7	1998-9	2000-1	2002-3	2004-5	2006-7
Poverty tenth:									
1 (poorest)	129	132	135	137	138	139	138	138	140
2	116	118	118	120	121	119	121	121	123
3	113	115	114	115	115	116	117	117	117
4	105	107	106	108	109	109	107	108	108
5	103	102	102	101	103	103	103	103	104
6	96	94	95	94	95	95	96	95	97
7	91	90	90	90	89	90	90	90	90
8	86	86	85	85	84	84	85	86	84
9	85	83	83	82	81	81	81	81	79
10	80	79	79	78	77	76	76	76	75
Ratio of worst to best (95% CI)	1.61 (1.61 to 1.62)	1.67 (1.66 to 1.67)	1.71 (1.70 to 1.72)	1.76 (1.75 to 1.77)	1.79 (1.79 to 1.80)	1.83 (1.82 to 1.83)	1.82 (1.81 to 1.83)	1.82 (1.81 to 1.82)	1.88 (1.87 to 1.88)
RII (95% CI)	1.61 (1.52 to 1.69)	1.67 (1.59 to 1.76)	1.71 (1.62 to 1.80)	1.81 (1.72 to 1.91)	1.86 (1.76 to 1.96)	1.86 (1.76 to 1.96)	1.90 (1.80 to 2.01)	1.91 (1.80 to 2.01)	2.14 (2.02 to 2.27)

*RII is relative rate of mortality for hypothetically worst-off compared with hypothetically best-off person in population, assuming linear association between socioeconomic position and mortality risk. Ratio of inequality is ratio of SMR of most deprived 10% to least deprived 10%.

sorted by various indicators to present a broad perspective on trends in mortality differentials.

METHODS

Digital mortality data were supplied with full postcodes for England and Wales by the Office for National Statistics and with postcode sector for Scotland from the General Register Office for Scotland. The postcode information is of the deceased's usual place of residence. We discarded the few records with no postcode (generally of deaths of visitors to Britain) and a few records with no code for cause of death (according to the international classification of diseases). The postcode was used to assign each death to the parliamentary constituency (as constituted in the 2001 general election) in which the deceased lived. Parliamentary constituencies are fairly uniform in population size; part of their rationale involves an attempt to maximise their homogeneity. The data on deaths were provided for single years and were grouped into two year aggregations.

At the time of the publication of results from the 1991 census it was generally agreed that the population had been substantially undercounted; this was corrected by researchers at the time, and we used the revised population figures in our previous work.[5] After the 2001 census, it became apparent that these corrections were themselves incorrect, and further corrections were made.[6] These revised "estimating with confidence" population figures for the 1991 census were aggregated from 1991 census wards to parliamentary constituencies and interpolated between 1991 and 2000. The mid-year population estimates released by the Office for National Statistics for census area statistics wards for England and Wales and by the General Register Office for Scotland for Datazones for Scotland were used for the years after 2000; the small area geographical data were aggregated to parliamentary constituencies. As the 2001 census and subsequent mid-year population estimates locate students studying away from home at their term-time addresses, we needed to relocate students studying away from home to their home constituencies.[7]

Poverty was indexed by the 2000 Breadline Britain Index.[8] This index measures relative poverty based on a lack of the perceived necessities of life and is widely accepted as a good measure of relative poverty. To avoid circularity we confirmed that the inclusion of any health measures in the index had no material effect on our results (analysis not shown). Parliamentary constituencies were ranked according to this poverty measure and divided into tenths of the population on the basis of this ranking. The tenth below the first decile has the highest poverty and the tenth above the last decile the lowest. We used the same ranking tenths for each of the time periods as the 1991 and 2000 Breadline Britain Indices were closely correlated (analysis not included). We calculated standardised mortality ratios under age 75 for men and women for these tenths by using their overall age specific mortality rates for Britain for the relevant time periods. A standardised mortality ratio of 100 means that there is no difference between the observed and the expected number of deaths in an area, the expectation being based on population size and age/sex structure. A ratio over 100 means that mortality is higher—for example, a ratio of 120 means that mortality is 20% higher than that of the general population.

These two changes (revised population estimates and an updated poverty measure) only minimally influenced the standardised mortality ratios previously published, and all summary statistics such as the relative index of inequality were calculated with the same methods as in our previous work.[5] Confidence intervals were estimated with standard methods.[9]

RESULTS

Premature death around the millennium

Table 1 shows the age and sex standardised mortality ratios for premature death (death below the age of 75)

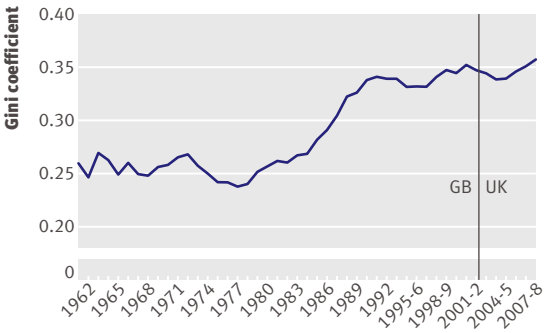

Fig 1 | Gini coefficient of equivalised inequality in income after tax and before housing costs, 1961 to 2007-8. Data are for Great Britain before 2002-3 and for UK subsequently. Source: Institute for Fiscal Studies

for 1990-2007; an expanded version with all confidence intervals is presented in table A on bmj.com. Table B on bmj.com shows the population years at risk and number of deaths by tenth of poverty. The worst-off tenth saw a gradual increase in standardised mortality ratio over the time period, while conversely the best-off tenth saw a decrease. The ratio of the worst to best tenths increased over the period, from 1.61 (95% confidence interval 1.61 to 1.62) in 1990-1 to 1.83 (1.82 to 1.83) by 2000-1, levelled off over the next four years, then increased to its maximum of 1.88 (1.87 to 1.88) for 2006-7. The confidence intervals for the standardised mortality ratios are tight because each is based on an underlying population of millions of people over two years. In contrast, the confidence intervals for the relative index of inequality figures are wider because they are based on 641 data points, each point being a parliamentary constituency. This index is the relative rate of mortality for the hypothetically worst-off compared with the hypothetically best-off person in the population, assuming a linear association between socioeconomic position and mortality risk. It has consistently risen over the time period, from 1.61 (1.52 to 1.69) in 1990-1 to 2.14 (2.02 to 2.27) in 2006-7.

The increase in the ratio and the relative index of inequality reflects the rising trend (and slight fall in the early 2000s) in income inequality. Figure 1 presents time series data on the Gini coefficient of equivalised inequality in income after tax and before housing costs.[10] There is debate as to whether income inequality has recently increased. Barnard states that "the Gini coefficient for disposable income was almost unchanged between 2006/07 and 2007/08",[11] while Brewer et al claim that, for the same period, "income inequality has risen (on most measures) in each of the last three years and is now at its highest level since our comparable time series began in 1961."[12]

Table C on bmj.com shows equivalent data to table B on bmj.com but for people dying at ages 0-64; table D on bmj.com shows the population years at risk and number of deaths by tenth of poverty. The inequalities are even starker, although the table shows that after increasing inequality to 1998-9, when the relative index of inequality stood at 2.38 (2.24 to 2.52), there was some narrowing until 2004-5 with an index of 2.27 (2.13 to 2.40). The index rose again for the most recent period 2006-7 to 2.38 (2.24 to 2.52) to match the maximum previously recorded, both for inequality ratio (in 2002-3) and by relative index (1998-9). In short, inequalities did fall a fraction in the earliest years of the current century but have since risen back to their previous maximum for people aged under 65 and exceed the previous maximum for those aged up to 74. For those aged under 65, the confidence intervals reported here are wider (the number of deaths involved are lower) and overlap.

Table E on bmj.com shows deaths of those aged 0-64 as a proportion of deaths in the 0-74 age range. Thus in the years 1990 and 1991, around 47% of people dying aged under age 75 in Britain were aged under 65 in the areas with the highest rates of poverty. By the end of the period that proportion had risen to 52%, resulting from a combination of faster falls in mortality from causes more likely to affect older people and because those in the unusually large birth cohort of 1946-7 were only in their mid-40s at the start of the period but in their 60s by the end. In general more of the dead are younger in poorer areas.

The longer historical picture

In previous work, we described standardised mortality ratios for deaths under age 65[13] for the period 1950-92 for areas of Britain. These statistics used only five age bands (age 0, 1-4, 5-14, 15-44, and 45-64) for men and women and were for areas amalgamated from the pre-1974 local authorities. As poverty data were not available for this extended time period, the areas were ranked at each time period by standardised mortality ratios before being grouped by each tenth of the population. Thus these data reflect the maximum geographical inequalities in mortality at each time period. We have now extended this time series back to 1921 and forward to 2007, aggregating the data for the 1920s, 1930s, 1980s, 1990s, and 2000s into approximate decades, and including all other data available for portions of other decades. Table 2 shows the standardised mortality ratios, the ratio of worst (highest ratios) to best (lowest ratios) tenths, and the relative index of inequality. The time periods are not continuous because of interruptions such as war or the government not collecting the relevant data; nor are the time periods always of equal duration.

From a ratio of 1.91 at the start of the time period (1921-30), there was a downward trend until around 1960; after this, the ratio decreased to the early 1970s, and since then the trend has been relentlessly upwards with a maximum of 2.12 by the mid-2000s, a ratio higher than at any other decade of the period. The relative index of inequality exhibits the same pattern.

Figure 2 shows the gap in life expectancy at birth for 1999-2008 between the local authority with the highest life expectancy and the local authority with the lowest life expectancy for males, females, and all people.[14] Although life expectancy has been increasing for all

Table 2 | Ratio of standardised mortality ratios (SMRs) (0-64) and relative index of inequality (RII) according to tenth of SMR, 1921-2007*

	1921-30	1931-9	1950-3	1959-63	1969-73	1981-9	1990-8	1999-2007
Tenth of standardised mortality ratio:								
1 (worst)	138.1	135.5	131.0	135.5	131.2	137.1	148.8	148.9
2	122.3	119.8	118.1	123.0	115.6	119.7	122.7	123.2
3	112.5	111.9	112.1	116.5	112.0	114.0	113.6	115.4
4	108.1	106.3	107.0	110.7	108.1	108.3	108.1	108.9
5	103.7	102.5	102.5	104.5	103.0	102.1	98.8	100.7
6	96.7	96.9	98.6	97.4	96.9	95.6	93.8	94.9
7	89.8	89.3	93.1	90.9	91.8	91.7	91.1	89.7
8	83.1	85.0	88.7	87.6	88.9	89.2	85.6	83.0
9	78.3	80.8	85.7	83.1	87.0	83.6	78.3	77.0
10	72.4	73.1	81.8	77.1	83.0	78.6	72.8	70.3
Ratio of worst to best	1.91	1.85	1.60	1.76	1.58	1.74	2.04	2.12
RII	2.50	2.35	1.96	2.25	1.92	2.17	2.64	2.79

*Data series is not continuous, with no data for 1940s and gaps in mid-'50s, mid-'60s, and from early '70s to early '80s; nor are time periods always of equal duration. For 1980s, we used harmonic mean of decile SMRs for two periods of which it was composed (1981-5 and 1986-9). Confidence intervals were unavailable for data for 1950s-1980s.

people over time, it has been increasing faster for the better off and the gap is now at its widest since 1991.

DISCUSSION

In this long time series (1921-2007) of records of deaths occurring under age 65 and (for historical comparability) age standardised by five broad age groups, we found that inequality in mortality between geographical areas in Britain has been increasing. The continuing rise in the standardised mortality ratio of those living in the areas with the highest tenth of mortality from 1997 onwards suggests that official government policy to reduce inequalities in health has not been successful, at least for the important indicator of premature mortality. The rate at which inequalities in health have continued to rise might seem to have slowed slightly towards the most recent period, but it is important to remember that there are still two years of the 2000s to be included in the series when the data are made available, and some underlying factors such as unemployment have been rising rapidly over the course of those two years; furthermore, in absolute numbers unemployment has increased fastest in the poorest areas.[15]

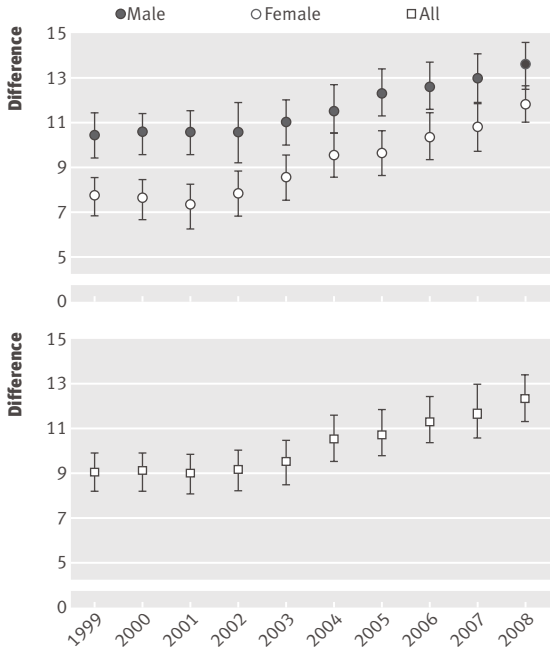

Fig 2 | Difference in life expectancy at birth between the best and worst off districts, 1999-2008

When considered by tenth of poverty, by the year 2007 for every 100 people under the age of 65 dying in the best-off areas, 199 were dying in the poorest tenth of areas. This is the highest relative inequality recorded since at least 1921. When we looked at people aged under 75, for every 100 people dying in the best-off areas, 188 were dying in the poorest tenth of areas. That is the highest ratio of inequality recorded since at least 1990.

The most informative guide to trends in geographical inequalities in premature mortality remains the relative index of inequality. This compares mortality rates between the poorest and least poor consistently defined groups of parliamentary constituencies in the country, and mortality rates for every constituency contribute to the index, not just the extreme tenths. The relative index of inequality rose quickly by six points from 1990-1 to 1992-3, and then more slowly to stand at 1.86 (1.76 to 1.96) by 1998-9, which held steady until 2000-1 before rising again to 1.91 (1.80 to 2.01) by 2004-5 and then to 2.14 (2.02 to 2.27) by 2006-7. This was the most marked increase recorded over the entire 1990-2007 period. That rise coincided with a rise in child poverty, which had been falling, and official recognition that inequality in income and wealth had also risen[16]—all before the current economic downturn became fully apparent.

The last rapid fall in inequalities in mortality between areas took 21 years, a world war, and introduction of a welfare state and a national health service

WHAT IS ALREADY KNOWN ON THIS TOPIC

Inequalities in mortality reflect inequalities in wealth and rise concurrently

People living in poorer areas have lower life expectancy than people living in less poor areas, and the gap in Britain is wide compared with that in other countries

WHAT THIS STUDY ADDS

The study brings previous research up to date and confirms that inequalities in mortality, when considered by wealth, are still increasing

Although life expectancy for all people is increasing, the gap between the best and worst districts is continuing to increase

Inequality in mortality is now greater than at any time since comparable records began

(between 1929 and 1950-3). Recent research on the immediate aftermath of the 1929-33 crash and depression suggests that in the short term inequalities in mortality between areas rose after the last large economic crash.[4] The longer term picture suggests that it was only prolonged and enthusiastic state intervention that reduced inequalities in mortality over this period and kept them low for a long time thereafter. These were interventions of the kind that kept the Gini coefficient low until 1978. Similarly, it could be argued that prolonged state disengagement in promoting equality in outcome over the period 1978-2007 allowed inequalities in health between areas of Britain to rise to their current maximum levels.

Strengths and limitations

Although this study was large, population based, and covered a longer time period than other reports, it had several limitations. By considering data aggregated by area we ran the risk of partly invoking the ecological fallacy but avoided the risk run by many studies in health inequalities of invoking the atomistic fallacy.[17] We did not examine the issue of migration, which will have a bearing on the results shown here. Selective out migration might lead to areas of decreasing relative size and high mortality,[18] but this is an issue for further study. Recent evidence from New Zealand suggests the differential patterns of migration by health status contribute substantially to geographical widening gaps, but such findings are context-specific and might not apply to Britain. [19] We considered only all cause mortality and did not examine the issue of changes in the underlying causes of death. We did this partly because of a paucity of data on cause of death by age, sex, and area for most of the time we considered.

Conclusions and policy implications

Social inequalities in mortality rates are influenced by complex and long term processes. They reflect the outcome of socially patterned exposures in early life and the cumulative effect of experiences in adult life.[20] Recent changes in social and fiscal policy and their consequences cannot be expected to eradicate such inequalities. They can, however, be judged with respect to predicted effect on social inequality in the short and long term, and from varying perspectives surprisingly little has been done to alter the fundamental structures of social inequality in the UK over the past decade.[21,22] Furthermore, over the next decade a combination of knock-on effects of the current downturn and relaxation of existent controls over tendencies for economic inequalities to rise will probably accelerate, rather than attenuate, the observed increases in inequalities in mortality. In this light the comprehensive but diffuse approaches in official responses to health inequalities[2,23] are inadequate. By treating the undoubted multidimensional contributors to health inequalities as though they act at the same level and by failing to prioritise the need to reduce the fundamental drivers of social inequality, the government's commitments to reduce inequalities in mortality have been largely ineffective, as predicted when the first such document, the Acheson report, was released.[24]

This paper is dedicated to the memory of Jerry Morris, a lifelong advocate of serious efforts to reduce inequalities in health.

Contributors: BT planned the study, analysed the data, discussed the results, and wrote the manuscript. DD planned the study, analysed the data, discussed the results, and wrote the manuscript. GDS planned the study, discussed the results, and wrote the manuscript. All authors saw and approved the final version. BT had full access to the individual specific mortality data used in the study, and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors had access to the processed tables and figures. BT and DD act as guarantors for the paper.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that all authors had: no financial support for the submitted work from anyone other than their employer; no financial relationships with commercial entities that might have an interest in the submitted work; and no non-financial interests that may be relevant to the submitted work.

Ethical approval: Ethical approval was not required.

Data sharing: No additional data available.

1 Department of Health. Independent inquiry into inequalities in health. Stationery Office, 1998.
2 Department of Health. Tackling health inequalities: 10 years on. Department of Health, 2009.
3 Marmot M, Atkinson T, Bell J, Black C, Broadfoot P, Cumberlege J, et al. Fair society, healthy lives: the Marmot Review Executive Summary. Marmot Review Team, 2010.
4 Dorling D, Thomas B. Geographical inequalities in health over the last century. In: Graham H, ed. Understanding health inequalities. Open University Press, 2009.
5 Davey Smith G, Dorling D, Mitchell R, Shaw M. Health inequalities in Britain: continuing increases up to the end of the 20th century. *J Epidemiol Community Health* 2002;56:434-5.
6 Norman P, Simpson L, Sabater A. Estimating with confidence and hindsight: new UK small area population estimates for 1991. *Population Space Place* 2008;14:449-72.
7 Shaw M, Thomas B, Davey Smith G, Dorling, D. The grim reaper's road map: an atlas of mortality in Britain. Policy Press, 2008.
8 Dorling D, Rigby J, Wheeler B, Ballas D, Thomas B, Fahmy E, et al. Poverty, wealth and place in Britain, 1968 to 2005. Policy Press, 2007.
9 Breslow N, Day NE. The analysis of case-control studies. International Agency for Research on Cancer, 1980.
10 Institute for Fiscal Studies. Fiscal facts. 2010. www.ifs.org.uk/fiscalFacts.
11 Barnard A. The effects of taxes and benefits on household income, 2007/8. *Economic Labour Market Rev* 2009;3:56-66.
12 Brewer M, Muriel A, Phillips D, Sibieta L. Poverty and inequality in the UK: 2009. Institute for Fiscal Studies, 2009.
13 Shaw M, Dorling D, Brimblecombe N. Changing the map: health in Britain 1951-91. *Sociol Health Illn* 1998;20:694-709.
14 Office for National Statistics. Correction notice: life expectancy at birth and at age 65 by local areas in the United Kingdom 2006-2008.

2009. www.statistics.gov.uk/downloads/theme_population/LE_UK_2009.xls.
15 Dorling D. Who will pay the price for the crisis? *Socialist Review* April 2009.
16 Elliot L, Curtis P. UK's income gap widest since 60s: Labour admits child poverty failure, incomes of poorest fall. *Guardian* 8 May 2009.
17 Tunstall HVZ, Shaw M, Dorling D. Places and health. *J Epidemiol Community Health* 2004;58:6-10.
18 Davey Smith G, Shaw M, Dorling D. Shrinking areas and mortality. *Lancet* 1998;352:1139-40.
19 Pearce JR, Dorling D. The influence of selective migration patterns among smokers and nonsmokers on geographical inequalities in health. *Ann Assoc Am Geogr* 2010:1-16.
20 Davey Smith G. Boyd Orr lecture: life-course approaches to inequalities in adult chronic disease risk. *Proc Nutr Soc* 2007;66:216-36.
21 Hills J, Sefton T, Stewart K, eds. Towards a more equal society? Policy Press, 2009.
22 Goldthorpe JH. Analysing social inequality: a critique of two recent contributions from economics and epidemiology. *Eur Sociol Rev* 2009doi:10.1093/esr/jcp046
23 Global Health Equity Group. Documents. 2010. www.ucl.ac.uk/gheg/marmotreview/Documents.
24 Davey Smith G, Morris JN, Shaw M. The independent inquiry into inequalities in health. *BMJ* 1998;317:1465-6.

Accepted: 18 May 2010