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## RESEARCH REPORT

## Income related inequalities in self assessed health in Britain: 1979–1995

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**Study objective:** To measure and decompose income related inequalities in self assessed health in England, Scotland, and Wales, 1979–1995.**Design:** The relation between individual health and a non-linear transformation of equivalised income, allowing for sex, age, country, and year effects, was estimated by multiple regression. The share of health attributable to transformed income and the Gini coefficient for transformed income were calculated. Inequality in health was measured by the partial concentration index, which is the product of the Gini coefficient and the share of health attributable to transformed income.**Participants and setting:** Representative annual samples of the adult population living in private households in Great Britain 1979–1995. The total analysed sample was 299 968 people.**Main results:** Pro-rich health inequality was largest in Wales and smallest in England over the period because the effect of increased income on health was greatest in Wales and least in England. In all three countries, pro-rich health inequality increased throughout the period. In the early 1980s this was primarily attributable to increases in income inequality. Thereafter the increased share of health attributable to income was the principal cause.**Conclusions:** Reductions in pro-rich health inequality can be achieved by reducing income inequality, reducing the effect of income on health, or both.

Socioeconomic inequalities in health arise if (1) socioeconomic circumstances influence health status and (2) there are inequalities in socioeconomic circumstances. Both factors could be a focus for policy, and differences in either could account for differences in health inequality between countries and over time.

Income is a broad measure of socioeconomic circumstances. It is unevenly distributed and strongly associated with health in all societies.<sup>1</sup> Average income in Britain has risen since the 1970s but income inequality has widened dramatically.<sup>2</sup> The evidence on trends in health in Britain is mixed: life expectancy has increased,<sup>3</sup> but self assessed levels of health status have shown little change.<sup>4</sup> Class related inequalities in mortality in Britain have widened steadily since the 1950s.<sup>5</sup> However, the trends in income related inequalities in self assessed health, and the extent to which they are attributable to widening income inequality, have not been established.

Scotland and Wales have lower life expectancy than England,<sup>6</sup> and Wales has higher rates of reported chronic morbidity than the other two countries.<sup>4</sup> However, little is known about the extent to which the poorer health of Wales and Scotland is attributable to their lower income.<sup>7</sup> Moreover, there have been no studies of differences in the level of income related inequalities in health between the countries in Britain.

Differences in income related inequality in health between countries must be attributable either to differences in the relation between health and income or to differences in the distribution of income. Similarly, changes over time in income related inequality in health must be attributable to changes in the income-health relation or in the distribution of income over time. It is an important first step in understanding differences or trends in income related health inequality to be able to attribute them to changes in the income-health relation or in the income distribution. In this paper we present a new method of decomposing income related inequality in health. We use it to compare income related inequalities in health across England, Wales, and Scotland over the period 1979–1995. We show how cross country and temporal differences in income related inequalities in health in Britain can be linked

to changes in income inequality and to changes in the share of health attributed to income.

## METHODS

## Data

Data on individual health and household income were obtained from 17 annual cross sections of the General Household Survey (GHS) for 1979–1995. The GHS is a representative survey of private households in England, Scotland, and Wales. The annual sample size fell throughout the period from 31 000 in 1979 to 23 500 in 1995. The health question was asked only of people aged 16 and over. Information on income and self assessed health is available for 306 107 people (81.6% of the initial adult sample). We omitted the 1st and 99th centiles of the income distribution to remove people reporting zero incomes and some very large income values that had disproportionate effects on the estimated income health relation. The resulting sample size is 299 968 (80.0%).

The measure of income is equivalised gross household income per week in 1995 prices. The equivalisation formula<sup>8</sup> was:

$$\text{Equivalised income} = \text{household income} / \sqrt{(\text{adults} + 0.5 \times \text{children})}$$

## Analysis

We estimated the determinants of individual health using a recently proposed procedure that has been validated on good quality Canadian data.<sup>9</sup> Self assessed health is measured in the GHS as an ordered categorical response to the question "How would you rate your health in general? Good, fairly good or not good". To increase the amount of information from the health measure we assume that health is in fact a continuous but unobserved variable ( $h'$ ) that lies between 0 and 1. A person who has  $h'$  between 0 and the critical value  $\alpha_1$  reports their health as "not good". One who has  $h'$  between the critical values  $\alpha_1$  and  $\alpha_2$  reports "fairly good" health and one who has  $h'$  between  $\alpha_2$  and 1 reports "good" health. If we know the critical values, we can use interval regression<sup>10</sup> to estimate the

most likely value of  $h^i$  for an individual given their reported health category, and their age, gender, and income.

We obtain the critical values from the 1996 Health Survey for England (HSE). The HSE contains the EuroQol EQ-5D<sup>11</sup> health instrument that asks about five dimensions of health. The EuroQoL answers from 16 047 respondents aged 16 and over were converted to a health utility scale between 0 and 1 using a set of weights for the UK based on the Time Trade-Off technique.<sup>12</sup> The quantiles of the resulting empirical distribution of HSE health utilities were matched with the cumulative frequencies of observations for the categories of self reported health ( $h^i$ ) in England in 1995 from the GHS. For example, in 1995 13.17% of the English GHS respondents reported "not good" health and 13.17% of the HSE respondents had a health score below 0.691. Hence we set the critical value  $\alpha_1$  equal to 0.691. Similarly we calculate  $\alpha_2 = 0.848$ .

Once the critical values are determined the individual level health function

$$h_{ijt}^s = \beta_0 + \beta_{jt}f(y_{ijt}) + x'\delta + u_j + v_t + \varepsilon_{ijt} \quad (1)$$

was estimated by interval regression with robust standard errors using STATA 7.0. Here  $i$  indexes individuals,  $j$  indexes countries, and  $t$  indexes years. The variable  $y$  is equivalised income,  $f(\cdot)$  is a transformation function,  $x$  is a vector of age and gender variables, and  $\varepsilon_{ijt} \sim N(0, \sigma^2)$ . Fixed effects for countries ( $u_j$ ) and years ( $v_t$ ) were estimated using vectors of dummy variables. The fixed effects specification of the multilevel model allows for correlation between the country and year dummies and the individual level variables.<sup>13</sup>

Previous studies have demonstrated that the relation between health and income is non-linear.<sup>14-16</sup> We compared linear, logarithmic and power forms of the health-income relation. The log-likelihood of the model was minimised when  $f(y) = y^{0.72}$ , so that increases in income improve health but have a smaller effect at higher incomes.

### Measurement of inequality

Wagstaff *et al*<sup>1</sup> reviewed measures of socioeconomic inequalities in health and suggested that the most appropriate was the *concentration index*. It is analogous to the Gini coefficient, commonly used as a measure of income inequality. The concentration index is derived by ranking the population by a measure of socioeconomic circumstances, such as income, and comparing the share of health accruing to people in differing circumstances with their share of the population. It has been widely used to measure inequalities in health and health care.<sup>18-21</sup>

The concentration index may be a misleading measure of the extent to which inequalities in health are directly attributable to income if there are other factors that affect health and are correlated with income. For example, elderly people generally report worse health status and have lower incomes than the rest of the population. Part of the relation between health and income in the concentration index will reflect the effect of age on health and the correlation between age and income. The extent of income related inequality in health will therefore be overstated by the concentration index of health on income. Hence it has been suggested that the concentration index should be based on standardised health from which the influence of factors correlated with income have been removed.<sup>22, 23</sup>

We used the *partial concentration index* (PCI), which is equivalent to the concentration index for directly-standardised health.<sup>23</sup> The PCI is

$$PCI = \frac{\beta \mu^{f(y)}}{\mu^h} C_y^{f(y)} \quad (2)$$

**Table 1** Interval regression analysis of self assessed health in Great Britain 1979–1995

Variable	Coefficient	t ratio
Female	0.00888	1.78
Age	0.36061	13.44
Age <sup>2</sup>	-1.10766	-18.07
Age <sup>3</sup>	0.71090	16.62
Female * Age	-0.23135	-6.23
Female * Age <sup>2</sup>	0.61604	7.41
Female * Age <sup>3</sup>	-0.44777	-7.86
Income <sup>0.72</sup>	0.00069	16.44
Wales	-0.01567	-7.37
Wales * Income <sup>0.72</sup>	0.00023	2.48
Scotland	-0.00354	-2.27
Scotland * Income <sup>0.72</sup>	0.00013	2.15
Constant	0.82142	202.42
Initial log-likelihood	-321329.54	
Model log-likelihood	-302755.44	
Pseudo-R <sup>2</sup>	5.78%	
Number of observations	299,968	
<i>Tests of restrictions</i>		
Year dummies = 0	$\chi^2_{(16)}=61.41$	p<0.0001
Income coefficient is time invariant	$\chi^2_{(16)}=69.33$	p<0.0001
Wales = England	$\chi^2_{(18)}=74.27$	p<0.0001
Scotland = England	$\chi^2_{(18)}=38.64$	p=0.0032

Other variables entered in the regression but not shown are (a) year effects; (b) year and income interaction effects; and (c) interaction terms for (country \* income \* year) effects. The tests of the restrictions at the foot of the table indicate their joint significance. The age variable is (age in years)/100.

where  $\beta$  is the income health coefficient from equation (1), and  $\mu^{(y)}$  and  $\mu^h$  are the means of transformed income and health.  $C_y^{(y)}$  is the Gini coefficient for transformed income.

The sign of the PCI is given by the sign of the coefficient  $\beta$ . We expect  $\beta$  to be positive and a positive PCI indicates that good health is disproportionately concentrated in the richest population groups. The PCI takes a minimum value of -1 when the poorest person is the only person that is healthy and a maximum value of +1 when the richest person is the only person that is healthy.

The PCI provides a useful decomposition of income related health inequality as the product of two terms. The first  $\beta \mu^{(y)} / \mu^h$  is the share of health attributable to income. Equivalently it is the proportionate change in health arising from a proportionate change in income, with all other factors affecting health held constant. Income related health inequality increases if the absolute effect ( $\beta$ ) of income on health or the mean of transformed income ( $\mu^{(y)}$ ) increase as these determine the overall effect of income on health. Note that if population health rises for reasons unconnected with changes in income, the share of health attributable to income decreases and so income related health inequality also falls.

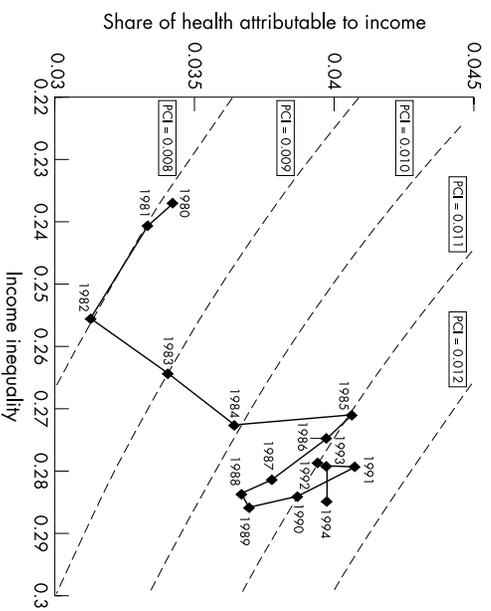
The second part of the PCI is the Gini coefficient of transformed income, which measures inequality in transformed income. In the present case, where  $f(y) = y^{0.72}$ , the Gini of transformed income is less than the Gini of raw income but the two measures are highly positively correlated across years and countries ( $r=0.998$ ). Increases in income inequality, as measured by the Gini of transformed income, increase income related health inequality.

The PCI and its component parts were estimated for each country for each year. Country specific, three year moving average values for the component parts were generated. The contribution of each of the four components to differences in the level of income related inequality in health between the start of the period (1979–1981) and the end of the period (1993–5) and between the three countries in 1993–5 were estimated. Three year moving average values of the level of inequality of transformed income ( $C_y^{(y)}$ ) and the share of

**Table 2** Components of income related health inequality in Great Britain, 1979–1995

Year	Income coefficient			Mean (Income <sup>0.72</sup> )			Mean Health			Gini (Income <sup>0.72</sup> )			Partial concentration index		
	England	Wales	Scotland	England	Wales	Scotland	England	Wales	Scotland	England	Wales	Scotland	England	Wales	Scotland
1979	0.00069	0.00092	0.00082	41.75	38.34	41.34	0.842	0.832	0.844	0.233	0.240	0.232	0.0080	0.0102	0.0093
1980	0.00064	0.00100	0.00070	42.16	39.57	41.29	0.838	0.834	0.839	0.235	0.237	0.235	0.0075	0.0113	0.0081
1981	0.00067	0.00100	0.00082	41.47	37.10	40.84	0.845	0.837	0.851	0.241	0.245	0.243	0.0079	0.0109	0.0096
1982	0.00066	0.00086	0.00078	40.77	37.79	39.26	0.846	0.833	0.847	0.244	0.241	0.246	0.0078	0.0094	0.0089
1983	0.00055	0.00081	0.00068	39.77	37.25	38.47	0.842	0.832	0.843	0.282	0.274	0.266	0.0073	0.0099	0.0083
1984	0.00087	0.00111	0.00088	41.18	35.71	39.36	0.849	0.835	0.843	0.268	0.259	0.274	0.0113	0.0123	0.0113
1985	0.00078	0.00105	0.00091	42.61	37.52	41.16	0.849	0.840	0.851	0.269	0.257	0.269	0.0106	0.0121	0.0118
1986	0.00075	0.00104	0.00085	43.47	38.69	41.28	0.846	0.835	0.846	0.275	0.271	0.275	0.0106	0.0131	0.0115
1987	0.00072	0.00106	0.00085	45.48	39.65	41.97	0.842	0.831	0.842	0.277	0.271	0.302	0.0108	0.0137	0.0128
1988	0.00059	0.00073	0.00072	47.49	42.42	43.87	0.844	0.830	0.844	0.289	0.283	0.294	0.0096	0.0106	0.0109
1989	0.00060	0.00091	0.00079	49.31	43.74	44.97	0.848	0.842	0.850	0.280	0.287	0.289	0.0098	0.0136	0.0121
1990	0.00069	0.00093	0.00073	49.35	45.40	45.15	0.844	0.838	0.839	0.285	0.273	0.300	0.0116	0.0138	0.0118
1991	0.00064	0.00103	0.00079	50.76	44.20	45.56	0.849	0.844	0.849	0.283	0.284	0.285	0.0108	0.0153	0.0121
1992	0.00069	0.00097	0.00084	50.97	45.41	47.37	0.846	0.839	0.847	0.267	0.255	0.275	0.0110	0.0134	0.0130
1993	0.00063	0.00084	0.00071	49.00	45.36	46.78	0.845	0.836	0.843	0.285	0.277	0.281	0.0103	0.0127	0.0110
1994	0.00067	0.00081	0.00074	49.83	45.31	48.10	0.843	0.828	0.844	0.287	0.277	0.278	0.0114	0.0123	0.0117
1995	0.00069	0.00101	0.00081	50.93	46.05	48.04	0.842	0.836	0.841	0.285	0.277	0.281	0.0118	0.0154	0.0130

The income coefficients are derived from the regression in table 1, including the coefficients on the year dummies, the country dummies and the interactions of interaction of year and country dummies. Mean (income<sup>0.72</sup>) is calculated by raising each individual's income to the power of 0.72 and then taking the mean. Mean health is mean individual health. Gini (income<sup>0.72</sup>) is the Gini coefficient for (income<sup>0.72</sup>). It is calculated by raising individual incomes to power of 0.72 and then cumulating the shares of the total of (income<sup>0.72</sup>) with individuals ranked in ascending order of income. The partial concentration coefficient is the product of the income coefficient, mean (income<sup>0.72</sup>), Gini (income<sup>0.72</sup>) divided by mean health.



**Figure 1** Decomposition of trend in health inequality in Britain 1980–1994. Points represent three year moving averages. Income denotes (income<sup>0.72</sup>).

health attributable to transformed income ( $\beta_{\text{H}}^{(19)}/\mu^m$ ) were plotted to show the evolution of income related health inequality in Britain over time.

**RESULTS**

The main regression results for the individual level health function are in table 1. Unsurprisingly, given the sample size, the individual level variables are highly significant. More important, their coefficients have plausible magnitudes and signs. Self assessed health is positively related to income, lower for women and decreases with age. Both Wales and Scotland have lower mean health and larger income-health coefficients than England.

Country specific, annual estimates of the four components of the PCI are in table 2. The income-health coefficient was largest in Wales and smallest in England in all years. Average (transformed) income was highest in England and smallest in Wales. Average health was consistently lower in Wales than in England and Scotland. Inequality in transformed income increased in all countries throughout the period. Income inequality in England was generally larger than in Wales and smaller than in Scotland. The final columns of table 2 show income related health inequality in the three countries. Health inequality was largest in Wales and smallest in England throughout the period.

Figure 1 shows the decomposition of the time trend in income related health inequality in Britain. The horizontal axis plots inequality in transformed income as measured by the Gini coefficient. The vertical axis plots the share of health attributable to transformed income (the product of the first three sets of columns in table 2). The rectangular hyperbolae in figure 1 give combinations of the share of health attributable to transformed income and of inequality in transformed income which give rise to the same level of income related health inequality. The movement from lower to higher contours over the period shows the increase in income related health inequality. The PCI was constant from 1980 and 1982 with increases in income inequality being offset by a reduced share of health attributable to income. From 1982 to 1989 income inequality continued to increase, with its effect on health inequality being reinforced and then offset by the rise and then fall in the share of health attributable to income. After 1989 income inequality changed little and the increase in the PCI was attributable to increases in the share of health attributable to income.

Table 3 shows the annual growth rates of the PCI and its components for England, Scotland, Wales, and Britain. In

**Table 3** Determinants of change in income related health inequality 1979–81 to 1993–95

	England		Scotland		Wales		Britain	
	% Growth rate per annum	Share of change in PCI	% Growth rate per annum	Share of change in PCI	% Growth rate per annum	Share of change in PCI	% Growth rate per annum	Share of change in PCI
Income coefficient	-0.06	-2.71%	-0.23	-12.42%	-0.62	-42.30%	-0.15	-6.71%
Mean transformed income	1.18	49.95%	0.98	51.95%	1.15	78.29%	1.17	52.00%
Mean health	0.01	-0.47%	-0.01	0.71%	0.00	0.34%	0.01	-0.36%
Share of health attributable to transformed income	1.11	46.77%	0.76	40.24%	0.53	36.33%	1.01	44.94%
Gini of transformed income	1.26	53.23%	1.12	59.76%	0.94	63.67%	1.23	55.06%
Partial concentration index	2.37		1.88		1.47		2.24	

Based on change over 15 years between 1978/80 to 1993/5 (three year averages). Growth rate of  $x$  calculated as  $(\ln(x_t/x_0))/t$ .

**Table 4** Contributions of components of partial concentration index to relative difference between England and Scotland and Wales, 1993/5

	England	Scotland		Wales			
	Variable	Variable	Relative difference from England*	Contribution of relative difference to relative difference in PCI†	Variable	Relative difference from England*	Contribution of relative difference to relative difference in PCI†
Income coefficient	0.00066	0.00075	13.1	201.4%	0.00089	29.55	158.7%
Mean transformed income	49.92	47.64	-4.67	-71.8%	45.57	-9.11	-48.9%
Mean health	0.8431	0.8427	-0.04	0.6%	0.834	-1.14	6.1%
Share of health attributable to transformed income	0.039	0.043	8.47	130.2%	0.049	21.58	115.9%
Gini of transformed income	0.286	0.280	-1.97	-30.2%	0.277	-2.96	-15.9%
Partial concentration index	0.0112	0.0119	6.50		0.0135	18.62	

\*Relative difference from England in variable  $x$  for country  $j$  is  $100\ln(x_j/x_E)$ , which can be approximated by the percentage difference  $(x_j-x_E)/x_E$ .

†Contribution of relative difference in  $x$  to relative difference from England in PCI is  $100\ln(x_j/x_E)/\ln(PCI_j/PCI_E)$ .

Britain as a whole 55% of the increase in the PCI was attributable to the increase in income inequality. The remainder of the increase was attributable to the increase in the share of health attributable to transformed income but, as the table shows, most of the change in the share was attributable to the increase in average incomes over the period. There was a slight decrease in the coefficient measuring the partial effect of income on health. Changes in mean health had little effect on the share of health attributable to transformed income and hence on the change in income related health inequality.

Table 4 compares the relative difference in the PCI and its components between England and the other two countries at the end of the period. The PCI was higher in Scotland and Wales than in England (the relative differences were 6.5% and 18.6% respectively), even though income inequality was slightly smaller in both countries than in England. The main cause of the difference in income related health inequality was the effect of income on health, which is greater in Scotland (relative difference 13.1%) and Wales (relative difference 29.6%) than in England.

## DISCUSSION

### Summary of findings

In 1993–5, although Wales and Scotland had more equal distributions of income than England, they had greater income related health inequality. The main reason is that income had a greater effect on health in Wales and Scotland than in England.

The principal causes of increased health inequality between 1979 and 1995 were rising income inequality and rising average incomes. Rising income inequality was the primary cause

### Key points

- Differences in income related health inequality are due to differences in the level of income inequality and the share of health attributable to income.
- Health inequality is higher in Scotland and Wales than in England because the effect of income on health is larger.
- 55% of the increase in income related health inequality over the period 1979–1995 was accounted for by the increase in income inequality and 45% by the increase in the share of health attributable to income
- The increase in the share of health attributable to income was due to the increase in average incomes rather than to changes in the effect of income on health.

in the early 1980s. Subsequently, the main driver of the increase in health inequality was the increased share of health attributable to income. There was little change in the effect of income on health over the period. However, incomes increased, so that the product of the effect of income and the mean of (transformed) income increased, thus increasing the share of health attributable to income.

Previous work has shown that Britain has wider health inequalities than would be expected for its level of income inequality<sup>1</sup> and that income differences between social groups in Britain are more important for health inequality than in Sweden.<sup>24</sup> Our results suggest that the share of health attributable to income accounts for the recent rise in health inequality in Britain and for the differences between countries within Britain.

### Limitations of study

The analysis has focused on health inequalities related to the distribution of current income. Previous studies have demonstrated that other socioeconomic variables have additional effects on health status<sup>25</sup> and that health may be more strongly related to “permanent” rather than “current” income.<sup>26</sup> We have used income as a composite indicator of economic status to summarise simply the relative importance for socioeconomic inequalities in health of (1) the effects of economic status on health and (2) the distribution of economic status across the population. Other methods are available for more detailed decompositions of health inequities to separate out the effects of income and of variables, such as education or housing, that are correlated with health and with income.<sup>23, 27</sup> A full analysis would require panel data but the only available panels do not cover a sufficiently long period to enable trends in inequality to be measured.

Although self assessed health has been found to be predictive of mortality for all social groups,<sup>28, 29</sup> it is categorical and its use in inequality studies requires assumptions about the underlying unobservable distribution of true health. Experiments with other standard assumptions<sup>30</sup> yielded very similar results.

### Policy implications

Reducing socioeconomic inequalities in health is a policy objective in many countries. Several commentators have drawn attention to the health implications of initiatives to reduce inequalities in socioeconomic circumstances.<sup>31, 32</sup> Our decomposition of the trend in income related health inequality over time reinforces but also qualifies such messages. Relatively little attention has been paid to initiatives that will reduce the effect of income on health. Our analysis demonstrates that the effect of income on health is an important part of the explanation of the cross country differences in income related health inequality among England, Scotland, and Wales. Consideration should also be given to attempts to reduce health inequality by reducing the effect of income on health as well as by reducing income differences.

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