PAPERS

Inequality in income and mortality in the United States: analysis of mortality and potential pathways

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Abstract

Objective—To examine the relation between health outcomes and the equality with which income is distributed in the United States.

Design—The degree of income inequality, defined as the percentage of total household income received by the less well off 50% of households, and changes in income inequality were calculated for the 50 states in 1980 and 1990. These measures were then examined in relation to all cause mortality adjusted for age for each state, age specific deaths, changes in mortalities, and other health outcomes and potential pathways for 1980, 1990, and 1989-91.

Main outcome measure—Age adjusted mortality from all causes.

Results—There was a significant correlation ($r=0.62$, $P<0.001$) between the percentage of total household income received by the less well off 50% in each state and all cause mortality, unaffected by adjustment for state median incomes. Income inequality was also significantly associated with age specific mortalities and rates of low birth weight, homicide, violent crime, work disability, expenditures on medical care and police protection, smoking, and sedentary activity. Rates of unemployment, imprisonment, recipients of income assistance and food stamps, lack of medical insurance, and educational outcomes were also worse as income inequality increased. Income inequality was also associated with mortality trends, and there was a suggestion of an impact of inequality trends on mortality trends.

Conclusions—Variations between states in the inequality of the distribution of income are significantly associated with variations between states in a large number of health outcomes and social indicators and with mortality trends. These differences parallel relative investments in human and social capital. Economic policies that influence income and wealth inequality may have an important impact on the health of countries.

Introduction

The inverse association between socioeconomic level and risk of disease is one of the most pervasive and enduring observations in public health.[1-4] This association is found for most diseases for most measures of socioeconomic level and is generally consistent across age, time, place, and organ systems. For the most part, socioeconomic level, whether it is measured by income, education, occupation, social class, or other measures, has been conceptualised as a property of the individual. This is not surprising as one's economic resources can determine, to a great extent, the availability and quality of food, housing, medical care, and other necessities. Recent findings, however, suggest that it may also be important to consider the overall distribution of wealth as a characteristic of a society or group. In a sample of industrialised countries Wilkinson demonstrated that life expectancy increased as the distribution of income in these countries became more egalitarian, whereas it was relatively unrelated to average income.[5] There was a correlation of −0.81 ($P<0.001$) between the proportion of the total income and benefits after tax received by the least well off 70% of the population and life expectancy. The correlation with gross national product per capita was only −0.38 ($P<0.05$). In addition, countries that had shown increases over time in the equality of income distribution had proportionally greater increases in life expectancy compared with countries that had shown increased inequality in income distribution.

These are compelling observations for several reasons. They suggest, as Wilkinson argues,[5,6] that within populations one's relative socioeconomic position not just the absolute level may be importantly associated with health. Understanding the mechanisms by which relative socioeconomic position leads to variations in health outcomes may help to understand the relatively consistent observation of a steady gradient of risk associated with variations in socioeconomic level, with even those near the top having higher rates of disease than those at the top. Furthermore, as governments, through taxation policy, benefits, income transfers, investment incentives, and other mechanisms, often alter the level of income inequality[7] such actions may also alter mortality, for better or worse. If this is the case then it is important to document such health effects so that they may be considered within the context of economic decisions. This is particularly compelling given the striking rise in the inequality in distributions of both wealth and income that have occurred over the past decade or so in the United States.[8-10]

Based as it is on a single set of observations concerning a small number of countries, the association between variations in income distribution and life expectancy needs to be examined in other contexts. We studied the relation between variations in income distribution between states of the United States and a variety of health outcomes, including variations in mortalities adjusted for age. In addition, we examined some of the potential pathways, possibly reflecting investments in human capital and social resources, by which income inequality may be related to health outcomes. Finally, we considered the impact of income inequality and changes in income inequality on mortality trends.

Methods

CALCULATION OF INCOME INEQUALITY

Income inequality is defined as the proportion of aggregated household income held by households whose income is below a specified centile on the

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distribution of household income. Income inequality has been calculated for the 10th to the 90th centiles for all 50 states and the United States as a whole. These measures were calculated by using data from the 1980 and 1990 censuses. For each state the distribution of household income for the year before the census was available. Annual household income (in dollars) was divided into 17 intervals in 1979 and 25 intervals in 1989. The distribution is given as the number of households in each income interval. In 1990, but not in 1980, the aggregate household income for households with annual incomes of less than the top coded category and in the top coded category was also available.

The distribution of household income was used to calculate the income corresponding to the 10th to the 90th centiles in steps of 10. This was done by calculating the cumulative percentage distribution, identifying the interval containing the desired centile, and using linear interpolation within that interval to calculate the income corresponding to that centile.

The aggregate income held by households below an income centile was then calculated as follows. For the closed intervals, the interval midpoint was multiplied by the number of households to determine the aggregate income in each interval. For 1990 the sum slightly exceeded the census value so the interval totals were adjusted downwards by multiplying them by the ratio of the census sum to the calculated sum. The cumulative percentage distribution of aggregate income was determined from the adjusted aggregate values and the census value for the last interval. Finally, linear interpolation was used to find the percentage of aggregate income that fell below each centile of the distribution of household income.

STATE MORTALITIES AND OTHER HEALTH OUTCOMES

State mortalities for 1980, 1990, and 1989-91 were based on the National Center for Health Statistics (NCHS) Compressed Mortality File and were adjusted for age by using the age distribution, divided into 13 groups, of the entire United States for 1990 and 1989-91. Data on low birth weight, live births, homicides, violent crimes, disability, and medical care expenditures were taken from United States Government sources published by NCHS.[11]

POTENTIAL PATHWAYS

Information on per capita expenditures by state and local governments for police protection and correction were based on data from the United States Bureau of the Census, Government Division,[12] and rates of incarceration in the population were from the United States Bureau of Justice Statistics.[13] Rates of receipt of income assistance (AFDC) are compiled by the Bureau of the Census from reports of the United States Social Security Administration and United States Administration for Children and Families.[14] Rates of receipt of food assistance (food stamps) come from the United States
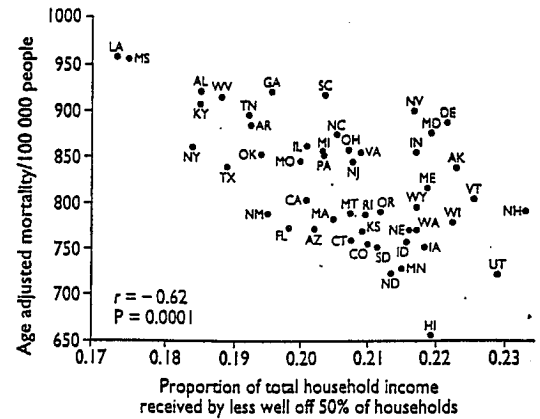

Fig 1—Inequality in income in the United States, 1990

States Department of Agriculture, Food and Nutrition Resources.[14] The Centers for Disease Control Behavioral Risk Factor Surveillance System was used for information on sedentary activity and smoking by state.[15] State rates on lack of health insurance were based on data from the Current Population Report,[16] and rates of high school graduation and drop out were from the 1990 Census of the Population.[17] Data from the National Assessment of Educational Progress were used for state 4th grade proficiency scores in reading and mathematics, which are published, together with the number of library books per capita and per capita spending on education, by the United States Department of Education, National Center for Education Statistics.[18] Unemployment rates are published by the United States Bureau of Labor Statistics.[19]

STATISTICAL METHODS

Pearson correlation coefficients were calculated to determine the association between measures of income inequality for the 50 states and age adjusted mortalities for males, females, and both sexes combined. Data for all other health outcomes and correlations between income inequality and potential pathways were based on fewer states as data were not available for all 50 in every case. To adjust for differences between states in absolute household income, partial correlation coefficients controlled for median income were also calculated. Because median income and expenditures per capita on medical care had highly skewed distributions a logarithmic transformation was applied before correlations were calculated. References to median income or total medical care expenditure refer to the natural log of the variable. For each state percentage changes between 1980 and 1990 in age adjusted mortalities, income inequality, and median income were also calculated.

Results

INCOME DISTRIBUTION AND MORTALITY

Table 1 presents the association between 1990 state mortalities adjusted for age and income inequality for the total population' and separately for males and females. The centile that designated the least well off proportion of each state varied from 10% to 90%. All correlations were significant (P < 0·05) and were little influenced by adjustment for median income. Similar results were seen when the correlations were adjusted for mean income. Figure 1 shows the relation between the proportion of total household income received by the less well off 50% of the population in each state in 1990 and mortalities adjusted for age (r=0·62; P < 0·001). When age specific death rates in broad categories were examined similar results were found, with the strongest correlation for deaths occurring at ages 25-64 years (r=0·76; P < 0·0001) (table 2).

Table 1—Correlation of 1990 mortality adjusted for age for all causes with proportion of total household income received by households below specified centile by sex, with and without adjustment for median income: United States, 1990

Centile	Adjusted for income			Not adjusted for income		
	Total	Male	Female	Total	Male	Female
10th	−0·67	−0·57	−0·58	−0·70	−0·60	−0·58
20th	−0·61	−0·59	−0·58	−0·65	−0·62	−0·56
30th	−0·62	−0·57	−0·58	−0·66	−0·61	−0·53
40th	−0·61	−0·54	−0·56	−0·64	−0·57	−0·50
50th	−0·59	−0·51	−0·54	−0·62	−0·54	−0·49
60th	−0·56	−0·47	−0·51	−0·60	−0·51	−0·47
70th	−0·53	−0·42	−0·48	−0·57	−0·47	−0·45
80th	−0·48	−0·37	−0·45	−0·53	−0·42	−0·43
90th	−0·39	−0·27	−0·38	−0·44	−0·33	−0·37

INCOME DISTRIBUTION AND OTHER HEALTH OUTCOMES

Table 3 indicates that the proportion of total household income received by the less well off 50% was also related to various other health outcomes. The strongest correlations were with rate of homicide ($r=0.74$; $P<0.0001$) and violent crime ($r=0.70$; $P<0.0001$), expenditure per capita on medical care ($r=0.67$; $P<0.001$), and percentage of live born infants who weigh less than 2500 g ($r=0.65$; $P<0.001$). States that had greater inequality in the distribution of income also had significantly higher rates of smoking, sedentary behaviour, and disability as well as greater expenditure per capita on police protection.

INCOME DISTRIBUTION, SOCIAL INDICATORS, AND INVESTMENTS IN HUMAN AND SOCIAL CAPITAL

Tables 4 and 5 present correlations between the proportion of total household income received by the less well off 50% and several indicators of social resources and relative investments in human and social capital. States that had greater inequality in the distribution of income also had higher rates of unemployment, incarceration, people receiving income assistance and food stamps, and medically uninsured. They also spent a smaller proportion of total spending on education and had poorer edu-

Table 2—*Correlation of 1989-91 mortality specific for age for all causes with proportion of total household income received by less well off 50% of households, with and without adjustment for median income: United States states, 1989-91*

Age at death (years)	Adjusted for income	
	Yes	No
<1	−0.54	−0.49
1-24	−0.53	−0.36
25-64	−0.76	−0.74
≥65	−0.42	−0.37

Table 3—*Correlation between various health outcomes and risk factors and proportion of total household income received by less well off 50% of households, adjusted for median income: United States states, 1989-91*

Outcome	r	P value
Proportion of live births <2500 g	−0.65	0.001
Homicides/100 000	−0.74	0.0001
Violent crimes/100 000	−0.70	0.0001
Proportion unable to work because of disability	−0.33	0.05
Per capita expenditures on protection	−0.38	0.007
Log per capita total medical care expenditures	−0.67	0.001
Proportion sedentary	−0.34	0.03
Proportion current smokers	−0.35	0.02

Table 4—*Correlation between social indicators and proportion of total household income received by less well off 50% of households, adjusted for median income: United States states, 1989-91*

Indicator	r	P value
Unemployment (%)	−0.48	0.001
Prisoners (%)	−0.44	0.01
AFDC (%)*	−0.69	0.001
Food stamps (%)†	−0.72	0.001
No health insurance (%)	−0.45	0.002

*Income assistance to low income families with children.
†Food vouchers for people with low income.

Table 5—*Correlation between education outcomes and indicators and proportion of total household income received by less well off 50% of households, adjusted for median income: United States states, 1989-91*

Measure	r	P value
No high school (%)	−0.71	0.001
High school dropout (%)	−0.50	0.001
Reading proficiency (4th grade)	0.58	0.001
Maths proficiency (4th grade)	0.64	0.001
Education spending/total spending	0.32	0.02
Library books per capita	0.42	0.002

cational outcomes, ranging from worse reading and proficiency in mathematics to lower rates of completion of high school education.

TRENDS IN MORTALITY AND INEQUALITY

The association between income inequality and age adjusted mortality was slightly lower in 1980 than in 1990 ($r=0.45$; $P<0.001$ v $r=0.62$; $P<0.001$). Income inequality in 1980 was a strong predictor of trends in mortality, measured as percentage change in age adjusted mortality between 1980 and 1990 ($r=0.62$; $P<0.0001$). States that were more unequal in income distribution experienced smaller declines in mortality during the decade. When this was adjusted for changes in median income for each state, states with greater inequality in income continued to show smaller declines in mortality ($r=0.51$; $P<0.002$).

Inequality in income increased in all states except Alaska between 1980 and 1990. The share of total household income received by the less well off 50% of the population decreased by 6.1% (range −11.5% to 2.9%). There was no important correlation between 1980-90 changes in state income inequality and 1980-90 trends in mortality ($r=0.12$; $P>0.05$), with or without adjustment for change in state median income or when various age specific mortalities were examined. When centile cuts for the income inequality measure were varied, however, there was a strong correlation between 1980-90 percentage change in the share of total income received by the least well off 10% of households and 1980-90 percentage change in age adjusted mortality ($r=0.53$; $P<0.001$), and this was not altered by adjustment for changes in state median incomes.

Discussion

These results indicate that variations in the relative equality of income distribution are significantly associated with various health outcomes, mortality over the life span, rates of behavioural risk factors, and markers for investment in human and social capital. As these analyses include all states, it cannot be argued that they are an artefact of the selection of a subset.[20] Strikingly, declines in mortality in the 1980s, experienced by all states, were smaller in states that had greater inequality in income at the beginning of the decade. When changes in income inequality were examined with respect to the worst off 10% of households in each state, increasing income inequality was associated with smaller declines in mortality over the decade.

Because these results are so striking it is important to consider various interpretive issues. It seems unlikely that these results are due only to differences in the average income between states. The correlation between median income and total mortality is weak ($r=0.28$; $P<0.05$) and is greatly reduced ($r=0.06$; $P>0.05$) with adjustment for the proportion of total household income received by the less well off 50%. On the contrary, the correlation between income inequality and total mortality is little influenced by

adjustment for log median income ($r=0.62$ without adjustment and $r=0.59$ with adjustment).

Inspection of figure 1 indicates that many of the states in which the proportion of total household income received by the less well off 50% is low are those with a higher proportion of African Americans. Given the higher mortality for African Americans the correlation between income inequality and mortality may simply reflect higher proportions of a higher mortality group in high inequality states. If this were true then there would be no correlation between variations in income distribution and variations in mortality in white people. The correlation between the proportion of total household income received by the less well off 50%, however, is almost the same for mortality in white ($r=0.51$; $P<0.0002$) and African American people ($r=0.52$; $P<0.0001$).

If greater income inequality is associated with poorer health then areas with high income inequality could, over time, show increases in income inequality due to downward economic drift of those who are sick. Thus, income distribution would, to some extent, be a reflection of the distribution of disease. Such selection effects have not proved to be very important in other studies of the association between socioeconomic status and health,[21] but they must occur to some extent. At any one time, however, relatively few people are sick, and the proportion of people in a state who are moving downward economically due to illness would be rather small; it is unlikely that this small proportion would have any major influence on income distribution, particularly in comparison with the impact of macroeconomic forces on distribution of income.

THE ECOLOGICAL FALLACY

These results also raise several interesting conceptual and methodological issues. Criticism is often directed at ecological analyses, of which these are an example, because it is not possible to control adequately for confounding and effect modification at the individual level—"the ecologic fallacy."[22] It should be recognised, however, that there are variables that can be measured only at this level.[23 24] The degree of income inequality is inherently such a variable because it is a property of the population not of the individual. Having said this, it is also important to ascertain the behavioural, psychosocial, and biological pathways by which income inequality affects the health experience of individual people. Such examinations will lead to an understanding of which segments of the population bear the burden on health of income inequality and the biological pathways that link income inequality to poor health. The results of these analyses suggest that the effects are quite strong and pervasive when the less well off 50% of the population are considered. Whether income distribution has similar effects on the health of poor, middle class, and rich people can be evaluated only through studies in which the health experience of individuals is examined in relation to income inequality.

In discussing his analyses of the relation between income distribution and differences in life expectancy between countries, Wilkinson argued that for developed nations it is not the absolute standard of living that is important but the levels of depression, isolation, insecurity, and anxiety that are associated with relative poverty.[1 25] Firstly, it should be recognised that these psychosocial characteristics are strongly patterned by socioeconomic level.[26] In addition, our results suggest that states with greater inequality in income have higher rates of violence, more disability, more people without health insurance, less investment in education and literacy, and poorer educational outcomes. It is reasonable to think that this translates, on average, into more difficult lives for those who live in such states. While there may be higher rates of adverse psychosocial outcomes in states with high inequality these may be only a reflection of the greater difficulties in life that are caused by the structural characteristics that distinguish between states with high and low inequality. From a prevention point of view it may be more important to deal with these structural features than their psychosocial consequences.

GEOGRAPHICAL AND TEMPORAL VARIATIONS

The current analyses consider the association between state variations in income distribution and mortality. To understand the nature of the association between income distribution and health outcomes properly, however, it will be necessary to consider various different levels of geographical scale. Ideally, health outcomes could be associated with measures of income distribution calculated for geographical units ranging from the state, to counties, to neighbourhoods. Examination of the changes in the magnitude and nature of these associations at different geographic levels could add much to our understanding of the pathways by which income distribution influences health.

Observations of geographical and temporal variations in health outcomes are one of the foundations of epidemiological analysis, and there have been numerous presentations of such variations in mortality in many countries, including the United States.[27-30] Presumably such variations reflect the combined effects of historical, cultural, environmental, and socioeconomic forces on the distribution of risk factors. For the most part, however, the studies are descriptive, and there is considerable speculation but little understanding of the reasons for either geographical patterning or time trends in mortality.[30-32] The contribution of this study is to point out the possible role of income inequality in explaining some of the spatial and temporal variation in state mortality in the United States. This does not rule out the contribution of other factors, but there are few data available to assess the magnitude of their contribution or their association with income inequality. The macroeconomic forces that generate income inequality may also have a substantial impact on patterns of job creation and investment which, in turn, influence migration, distribution and concentration of community resources and demands, and maintenance and abandonment of practices specific to culture, thereby helping to shape the history of an area. Testing such a hypothesis, however, is beyond the scope of the current analyses.

MACROECONOMIC EFFECTS

Because considerable increases in income and wealth inequality in the United States during the past 10 to 15 years have been reported (EN Wolff, 23rd general conference of the International Association for Research in Income and Wealth, St Andrews, New Brunswick, Canada, 1994) it was of interest to examine the association between secular trends in inequality and health outcomes. Such analyses are not necessarily informative as we do not know whether or not there are lags between changes in income inequality and mortality. Overall, however, there was no association between trends in income inequality and trends in mortality. This may reflect the small interstate variation in inequality increases: for 48 of 50 states the percentage change in inequality, defined at the 50th centile, varied only from -2% to -12%. Thus, the macroeconomic effects that resulted in increases in income inequality may have influenced all states similarly. The largest variation was seen when we examined changes in the proportion of total household

Key messages

- It has been suggested that differences in the equality with which income is distributed may be related to variations in health between and within countries, but it had not previously been examined with respect to variations in mortality within a country

- There was a significant correlation ($r=0.62$) between the proportion of total household income received by the less well off 50% of households and variation between states in death rates for the United States

- Income inequality was also significantly related to changes in mortality with smaller declines between 1980-90 in those states with greater income inequality

- Income inequality was associated with a large number of other health outcomes and with measures related to investments in human and social capital

- Economic policies that increase income inequality may also have a deleterious effect on population health

income received by the least well off 10% of the population. For this measure there was a mean decrease of 8.9% with a wide range (-32.4% to 23.8%), and there was a strong correlation with mortality changes ($r=0.53$). The macroeconomic effects on income inequality may be felt sooner at the bottom of the income distribution, and states may vary in the extent to which these effects are buffered by employment, taxation, and welfare policies. It is tempting to assume that the poorer mortality trends in those states in which income inequality increased are due to increased deaths rates among those who occupy the lower economic strata. Such a hypothesis cannot be tested, however, with the aggregate data used in the present analyses.

CONCLUSIONS

To our knowledge, this is the first report of an association between variations in income distribution within a single country and a variety of health outcomes. If these results are confirmed in other analyses there should be cause for concern. Given that inequalities in wealth are far greater than those for income in the United States[8] the health effects of inequality are likely to be even larger than those suggested by the current results. In addition, inequality in both wealth and income has increased dramatically in the United States, with wealth inequality reaching levels beyond those in other industrialised countries. While there is no complete consensus over the reasons for increases in inequality, factors identified generally include policies related to taxation, transfer payments, job creation and differential growth decay of various market sectors, and differential growth of assets—for example, housing v stocks. In the United States between 1981 and 1989 nearly half of the growth in wealth inequality was due to increases in income inequality and 21% due to increases in stock prices relative to housing (E N Woolf, 23rd general conference, New Brunswick, Canada, 1994). From 1983 to 1989, 66% of the total gain in net financial wealth was received by the top 1%, 37% by the next 19% of the population, and the bottom 80% lost 3%.[8] The current results suggest that either the mortality effects of these changes are focused on the very poor or that income inequality among the poor affects mortality trends among the entire population or that

worsening income inequality among the poorest is a harbinger of trends in larger segments of the population. Whichever possibility is true there is cause for alarm given the increasing inequality of income and wealth in the United States.

While the present results do not prove that income inequality causes poor health, the results are dramatic and suggestive enough to make further research in this area a high priority. Because of the strength and consistency of the associations between income distribution and health outcomes, the impact of inequality on mortality trends, and the suggestive evidence concerning the impact of trends in inequality, it would be prudent to consider health effects, and the costs associated with them when the impact of economic policies is evaluated.

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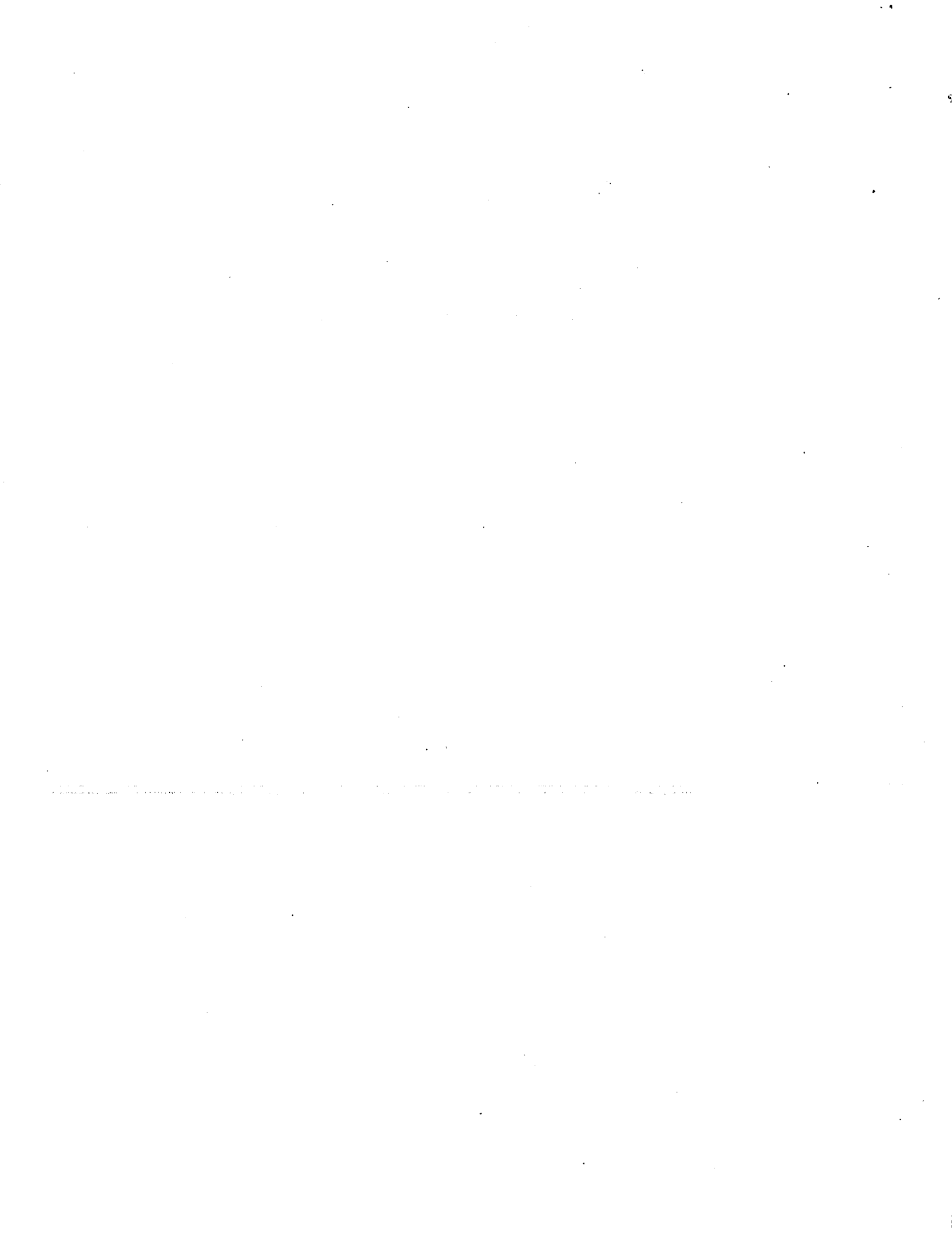
Correction for **Kaplan et al., *BMJ* 312 (7037) 999-1003.**

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Correction

Inequality in income and mortality in the United States: analysis of mortality and potential pathways

A production error occurred in this paper by George A Kaplan and colleagues (20 April, pp 999-1003) in which the minus signs were deleted from some correlation coefficients (r). Thus in the results section of the abstract (p 999) and in the key messages (p 1003) the coefficient should be -0.62 (not 0.62). Similarly, in results under income distribution and mortality (p 1000) the two coefficients should be -0.62 and -0.76; in the section under income distribution and other health outcomes (p 1001) the coefficients should be -0.74, -0.70, -0.67, and -0.65; and in the section under trends in mortality and inequality (p 1001) the coefficients should be -0.45 and -0.62 in the first sentence of the first paragraph and -0.53 in the last sentence of the second paragraph: In the discussion the coefficients should be -0.28, -0.06, -0.62, -0.59, -0.51, -0.52 in the second and third paragraphs (pp 1001-2) and -0.53 in the fifth sentence under macroeconomic effects (p 1003).