Quality, Outcomes, and Satisfaction

Individual Income, Income Inequality, Health, and Mortality: What Are the Relationships?

Kevin Fiscella and Peter Franks

Objective. To examine the pathways between income inequality, self-rated health, and mortality in the United States.
Data Source. The first National Health and Nutrition Examination Survey and Epidemiologic Follow-up Study.
Design. This was a longitudinal, multilevel study.
Data Collection. Baseline data were collected on county income inequality, individual income, age, sex, self-rated health, level of depressive symptoms, and severity of biomedical morbidity from physical examination. Follow-up data included self-rated health assessed in 1982 through 1984 and mortality through 1987.
Principal Findings. After adjustment for age and sex, income inequality had a modest independent effect on the level of depressive symptoms, and on baseline and follow-up self-rated health, but no independent effect on biomedical morbidity or subsequent mortality. Individual income had a larger effect on severity of biomedical morbidity, level of depressive symptoms, baseline and follow-up self-rated health, and mortality.
Conclusion. Income inequality appears to have a small effect on self-rated health but not mortality; the effect is mediated in part by psychological, but not biomedical pathways. Individual income has a much larger effect on all of the health pathways.
Key Words. Socioeconomic factors, mortality, health status, social class

Well-controlled prospective studies have documented powerful effects of individual socioeconomic position on subsequent health, including mortality

Kevin Fiscella, M.D., M.P.H. is Associate Professor of Family Medicine in the Primary Care Institute, Highland Hospital, and Departments of Family Medicine and Community and Preventive Medicine, University of Rochester School of Medicine and Dentistry; Peter Franks, M.D. is in the Primary Care Institute, Highland Hospital and the Department of Family Medicine, University of Rochester School of Medicine and Dentistry. Address correspondence to Dr. Fiscella at Family Medicine Center, 885 South Avenue, Rochester NY 14620. This article, submitted to *Health Services Research* on July 27, 1999, was revised and accepted for publication on October 25, 1999.

(Hemingway, Stafford, Stansfeld, et al. 1997; Sorlie, Backlund, and Keller 1995; Lantz, House, Lepkowski, et al. 1998). In the past decade, attention has shifted from a focus exclusively on the impact of individual socioeconomic factors toward the impact of population income distribution on health (Wilkinson 1996; Kaplan, Pamuk, Lynch, et al. 1996; Kennedy, Kawachi, and Prothrow-Stith 1996; Lynch and Kaplan 1997). A number of ecological studies have shown that higher income inequality, measured at the national, state, or community level, is associated with poorer population health (Kaplan, Pamuk, Lynch, et al. 1996; Kennedy, Kawachi, and Prothrow-Stith 1996; LeGrand 1987; Rodgers 1979; Lynch, Kaplan, Pamuk, et al. 1998; Ben-Shlomo White, and Marmot 1996).

However, multilevel studies that control for the effect of individual income have reached conflicting conclusions regarding the association of income inequality and health. We previously reported that the observed ecological association between community or county income inequality and subsequent mortality disappeared after controlling for individual income (Fiscella and Franks 1997). Daly et al. (1998) also reported no overall association between state income inequality and five-year mortality. In contrast, Kennedy et al. (1998) found a modest, but statistically significant association between state income inequality and self-rated health after controlling for individual characteristics including income. Soobader and LeClere (1999) have also noted an independent relationship between income inequality at the county level and self-rated health. Lochner, Pamuk, Makuc, et al. (1999) recently presented data showing that U.S. state income inequality may have a very modest but statistically significant effect on mortality. Thus, the relationships among income inequality, self-rated health, and mortality appears uncertain.

One potential explanation for these discrepant findings is that income inequality is more strongly associated with self-rated health than is mortality. Although self-rated health predicts mortality (Idler and Benyamini 1997), it is composed primarily of two domains, physical and mental health (Ware 1994), that may contribute unequally to mortality.

Based on findings cited earlier (Daly et al. 1998; Kennedy et al. 1998), we hypothesized that community income inequality would be associated with self-rated health. Furthermore, based on Wilkinson's hypothesis that income inequality effects are primarily mediated through psychological distress (Wilkinson 1996, 1997), we hypothesized that these effects would be mediated primarily through depressive symptoms, as opposed to biomedical health.

METHODS

Source of Data

The first National Health and Nutrition Examination Survey (NHANES I), conducted between 1971 and 1975 in the United States, collected sociodemographic data from multiple national probability samples of the civilian noninstitutionalized population of adults age 25 to 74 years (Miller 1977; Engel et al. 1978). The NHANES I Epidemiologic Follow-up Study (NHEFS) collected mortality data through follow-up surveys conducted in 1982 through 1984, 1986, and 1987 (Cohen, Barbano, Cox, et al. 1987; Madans, Cox, Kleinman, et al. 1986). Follow-up data were derived from interview surveys, medical records from health care institutions, and death certificates for all decedents. The age, race, and sex-specific mortality of the NHEFS cohort is comparable to that experienced by the U.S. population (Madans, Cox, Kleinman, et al. 1986). A total of 14,407 persons took part in the original survey, 3.4 percent of whom had missing family income information. Of persons with family income information, mortality status at follow-up was ascertained on 95.8 percent.

The NHANES I used multistage stratified probability samples of persons from 105 areas, or Primary Sampling Units (PSUs), in the United States. The areas approximated counties or combined county areas (Miller 1977; Engel et al. 1978). Persons living in poverty areas, women of childbearing age, and elderly persons were oversampled. A mean of 131 persons were surveyed in each PSU (range 48–323). The revised weights provided on the 1987 NHEFS public use tapes were used to adjust for survey oversampling and nonresponse to yield population estimates for each community surveyed.

MEASURES

Household income was assessed through response to a single question in NHANES I: "Please look at this card—which one of these income groups represents yours, your _____'s etc., total combined family income for the past 12 months, that is since (date) a year ago? Include income from all sources such as wages, salaries, social security or retirement benefits, help from relatives, rent from property and so forth." On the card, 12 income categories ranging from under $1,000 to $25,000 and over were presented to the subject. Subjects were assigned to the mean value within their income category. Subjects in the highest income category (4.6 percent) were assigned a mean value by extrapolation.

Several indexes of community income inequality have been described, although the relationship of each index to mortality risk is similar (Kennedy, Kawachi, and Prothrow-Stith 1996). We used an index that estimates the proportion of total income earned by the poorer half of the population in the area. The denominator for this index is the total aggregate income in the community (PSU) and the numerator is the aggregate income in the community earned by the poorer 50 percent of the population. The income inequality within the communities ranged from 0.18 through 0.37.

A representative subsample of 6,913 NHANES I participants were also asked questions that covered the General Well-Being (GWB) Schedule. Four of these questions comprise a previously validated depression subscale (GWB-D) (Fazio 1977). The GWB-D scale is scored from 0 through 25, with lower scores indicating more depressive symptoms. The scale includes questions about mood in the week prior to the interview. The Cronbach reliability of the scale is 0.77, and it is highly correlated with other scales designed to measure depressive symptoms (Fazio 1977).

Self-rated health was assessed based on the question: "Would you say your health in general is . . . ?" The five responses ranged from poor to excellent. Responses were coded as ordinal variables, with poor health receiving lower scores.

Physical health was assessed based on a physician's complete physical examination of the subject and review of laboratory, EKG, pulmonary function, and radiologic test results (Miller 1977). Physicians recorded the diagnosis and judged the severity of the condition according to a three-point scale (minimum, moderate, severe). Respondents were assigned a level of biomedical morbidity based on their most severe recorded condition. Those without disease were assigned a score of "0."

Statistical Analysis

Multilevel modeling is required to avoid the problems of within-group clustering (Morgenstern 1995). We used the statistical package SUDAAN, which uses a Taylor series approximation method to compute variances that allow adjustment for the multistage probability sampling strategy (Research Triangle Institute 1991). We conducted a series of regression analyses to examine the relationships among individual income, income inequality, level of depressive symptoms, level of biomedical morbidity, baseline and follow-up self-rated health, and mortality. For analyses with biomedical morbidity and self-rated health as dependent variables, we used cumulative logistic regression models;

for the analysis with level of depressive symptoms as the dependent variable, linear regression was used. Finally, a Cox proportional hazard survival analysis was used to examine the predictive model for mortality. All models included age, sex, individual income, and income inequality as independent variables. In the regression analyses with self-rated health as the dependent variables, both the level of biomedical morbidity and that of depressive symptoms were also included as independent variables. The survival analysis also included baseline self-rated health as an independent variable.

RESULTS

Table 1 shows the results of the series of regression analyses examining our hypothesized causal sequence. Income inequality had a statistically significant independent association with the level of depressive symptoms and with baseline and follow-up self-rated health. Inequality exhibited no relationship with baseline biomedical morbidity or follow-up mortality. Income exhibited much stronger relationships with all of the measures: depressive symptoms, biomedical morbidity, baseline and follow-up self-rated health, and mortality. The statistically significant relationships among all these variables are shown in Figure 1.

When severity of biomedical morbidity and level of depressive symptoms were excluded from the analyses, the relationship between inequality and self-rated health increased slightly; the adjusted odds ratio (AOR) for a one standard deviation increase in income inequality was 1.18 (95% confidence interval (CI) = 1.12, 1.24) for baseline self-rated health, and the AOR was 1.19 (95% CI = 1.12, 1.27) for follow-up self-rated health. When severity of biomedical morbidity, level of depressive symptoms, and baseline self-rated health were excluded, there was still no relationship between income inequality and mortality (adjusted hazard ratio (AHR) = 1.01 (95% CI = 0.99, 1.04). When income-squared was included in the analyses, the relationship between income inequality and follow-up self-rated health was slightly reduced (AOR = 1.15; 95% CI = 1.12, 1.19), and there remained no relationship between inequality and mortality (AHR = 1.00; 95% CI = 0.97, 1.02).

DISCUSSION

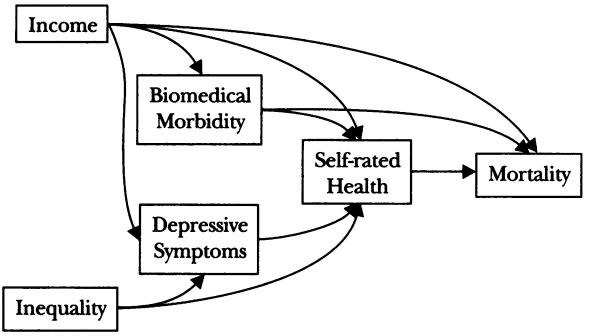
These findings provide new insights into the relationships among income, income inequality, self-rated health, and mortality. They confirm previous

Table 1 Adjusted Relationships of Income and Inequality with Depressive Symptoms, Level of Biomedical Morbidity, Self-rated Health, and Mortality

Risk Factor	*Depressive Symptoms*	*Biomedical Morbidity*	*Baseline SRH*	*Follow-up SRH*	*Mortality*
Income	−0.69 (−0.64, −0.74)	0.89 (0.87, 0.92)	1.49 (1.46, 1.53)	1.41 (1.38, 1.45)	0.80 (0.77, 0.83)
Inequality	−0.21 (−0.13, −0.28)	0.98 (0.92, 1.05)	1.16 (1.12, 1.20)	1.16 (1.12, 1.20)	1.03 (0.99, 1.07)
Morbidity			0.49 (0.47, 0.51)	0.57 (0.55, 0.59)	1.21 (1.16, 1.26)
Depression			0.70 (0.67, 0.72)	0.76 (0.74, 0.78)	1.03 (0.99, 1.06)
Baseline SRH					0.86 (0.83, 0.88)

Notes: SRH = self-rated health; higher scores are associated with better health. Higher inequality scores are associated with greater community income equality. Each column represents a separate regression analysis. The results indicate the impact on the dependent variable associated with a one standard deviation change in the risk factor (and a 95 percent confidence interval in parentheses). The level of depressive symptoms analysis is a linear regression model, the biomedical morbidity and self-rated health analyses are cumulative proportional-odds logistic regression models, and the mortality analysis is a proportional hazards model. All analyses are also adjusted for age and sex.

Figure 1: Statistically Significant Pathways Among Examined Variables



reports (Kennedy et al. 1998; Soobader and LeClere 1999) of a modest, but statistically significant, relationship between income inequality and self-rated health. As in previous reports, these effects are substantially smaller than the association between individual income and self-rated health; the effects of income on self-rated health are an order of magnitude more powerful than income inequality. The findings also demonstrate that the relationship between income inequality and self-rated health is in part mediated by depressive symptoms. This finding is consistent with the suggestion that depressive symptoms resulting from perceptions of relative deprivation mediate the effects of income inequality on health (Wilkinson 1997). Last, the findings show no association between income inequality and biomedical morbidity based on physicians' assessments. Previous studies have suggested that underlying biomedical morbidity largely accounts for the relationship between self-rated health and mortality (Kaplan, Pamuk, Lynch, et al. 1996; Korten, Jorm, Letenneur, et al. 1999). Similarly, in our analyses it was primarily biomedical morbidity, not psychosocial distress, that mediated the relationship between self-rated health and subsequent mortality.

These findings offer an explanation for conflicting reports regarding the association between income inequality, self-rated health, and mortality. Income inequality is associated with self-rated health and not mortality because its association is mediated largely through psychological distress, which may be a weaker predictor of mortality than of biomedical morbidity. In addition, the findings that the association between income inequality and self-rated health is attenuated by adjustment for the nonlinear relationship between individual income and health confirms previous suggestions that the

association between income inequality and health is at least partly explained by the nonlinear relationship between income and health (Rodgers 1979; Fiscella and Franks 1997; Gravelle 1998).

Although these findings suggest that the association between income, mortality, and self-rated health is partly mediated by psychosocial distress, we cannot determine from our data whether these represent direct effects of depressive symptoms on self-rated health, as suggested by Wilkinson (1996); indirect effects, such as public spending for education, public health, or education (Smith 1996); or unmeasured confounding. Previous studies support the latter two explanations. Mellor and Milyo (1999) show that the relationship between income inequality, measured at the state level, and self-rated health disappears after adjustment for unmeasured state-level fixed effects, suggesting that other factors closely associated with income inequality are responsible. In addition, childhood social class may confound the relationship between income inequality and self-rated health. Recent data show that childhood social class predicts self-rated health independently of adult social class and that this relationship is partly mediated by depressive symptoms and coping style (Bosma, Dike van de Mheen, and Mackenbach 1999). If lower childhood social class is associated with residence as an adult in areas with greater income inequality, then childhood social class confounds the relationship between income inequality and self-rated health.

The limitations of these findings merit comment. First, these findings are limited by the area sampling methodology used by NHANES I. Although the survey was designed as a representative sample of the United States, sampling within communities was not random. The cluster sampling strategy underestimates the true variability within each community, thus underestimating community income inequality. However, we believe it to be unlikely that such potential measurement error contributed to our findings for several reasons. In our earlier analysis, we successfully replicated the ecological findings of others using this measure of income inequality. In this analysis, we replicated the findings from larger samples of an association between income inequality and self-rated health. Given our smaller sample, any appreciable error in our measure would likely preclude the detection of such a modest association.

Second, Wilkinson has argued that the absence of a relationship between income inequality and mortality reflects the level of aggregation studied and that effects of income equality are stronger at the national or state level than at the county or community level (Wilkinson 1997). However, we observed a relationship between inequality and self-rated health relative to income that was comparable to that reported by Kennedy et al. (1998), who used state-level

aggregation. Also, previous studies have shown relationships between income inequality and health at a level similar to ours (Lynch, Kaplan, Pamuk, et al. 1998; Ben-Shlomo, White, and Marmot 1996; Soobader and LeClere 1999). In addition, Mellor and Milyo (1999) found no difference in associations at the state versus the county level.

Third, it is possible that our sample size is sufficient to detect effects on self-rated health, but not on mortality. Depressive symptoms, particularly depression, independently predict cardiovascular mortality and/or all-cause mortality (Frasure-Smith, Lesperance, and Talajic 1993; Anda, Williamson, Jones, et al. 1993; Everson, Goldberg, Kaplan, et al. 1996). The association between income inequality and depressive symptoms may be too modest to yield significant mortality effects in this sample. However, the narrow confidence intervals surrounding the estimate of the association between income inequality and mortality preclude all but a slight association.

Last, unmeasured community characteristics may have confounded the relationship between income inequality and health status. However, insofar as these characteristics are manifestations of income inequality, such as lack of economic opportunity, unsafe environments, or public spending, they may represent mediators rather than confounders. Further study is needed to clarify these important questions.

In conclusion, community income inequality is modestly associated with self-rated health, but not with mortality. This relationship is mediated, in part, by psychosocial distress, but not by biomedical morbidity. In contrast, the relationship between individual income and self-rated health is mediated through both pathways, resulting in substantial effects on subsequent mortality.

REFERENCES

Anda, R., D. Williamson, D. Jones, C. Macera, E. Eaker, A. Glassman, and J. Marks. 1993. "Depressed Affect, Hopelessness, and the Risk of Ischemic Heart Disease in a Cohort of U.S. Adults." *Epidemiology* 4 (4): 285–94.

Ben-Shlomo, Y., I. R. White, and M. Marmot. 1996. "Does the Variation in the Socioeconomic Characteristics of an Area Affect Mortality?" *British Medical Journal* 312 (7037): 1013–14.

Bosma, H., H. D. Dike van de Mheen, and J. P. Mackenbach. 1999. "Social Class in Childhood and General Health in Adulthood: Questionnaire Study of Contribution of Psychological Attributes." *British Medical Journal* 318 (7175): 18–22.

Cohen, B. B., H. E. Barbano, C. E. Cox, J. J. Feldman, F. F. Finucane, J. C. Kleinman, and J. H. Madans. 1987. "Plan and Operation of the NHANES I Epidemiologic

Followup Study, 1982–84." *Vital and Health Statistics, Series 1, No. 22. DHHS Pub. No. (PHS) 87-1324. Washington, DC: Government Printing Office.*

Daly, M. C., G. J. Duncan, G. A. Kaplan, and J. W. Lynch. 1998. "Macro-to-Micro Links in the Relation Between Income Inequality and Mortality." *Milbank Quarterly* 76 (3): 315–39, 303–304.

Engel, A., R. S. Murphy, K. Maurer, and E. Collins. 1978. "Plan and Operation of the NHANES I Augmentation Survey of Adults 25–74 Years, United States, 1974–75." *Vital and Health Statistics,* Series 1, no. 14. DHEW Pub. No. (PHS) 78–1314. Washington, DC: Government Printing Office.

Everson, S. A., D. E. Goldberg, G. A. Kaplan, R. D. Cohen, E. Pukkala, J. Tuomilehto, and J. T. Salonen. 1996. "Hopelessness and Risk of Mortality and Incidence of Myocardial Infarction and Cancer." *Psychosomatic Medicine* 58 (2): 113–21.

Fazio, A. F. 1977. "A Concurrent Validational Study of the NCHGS General Well-Being Schedule." *Vital and Health Statistics, Series 2: Data Evaluation and Methods Research.* DHHS Pub. No. (PHS) 1–53. Washington, DC: Government Printing Office.

Fiscella, K., and P. Franks. 1997. "Poverty or Income Inequality as a Predictor of Mortality: Longitudinal Cohort Study." *British Medical Journal* 314 (7096): 1724–28.

Frasure-Smith, N., F. Lesperance, and M. Talajic. 1993. "Depression Following Myocardial Infarction: Impact on 6-month Survival." *Journal of the American Medical Association 270 (15): 1819–25.*

Gravelle, H. 1998. "How Much of the Relation Between Population Mortality and Unequal Distribution of Income Is a Statistical Artifact?" *British Medical Journal* 316 (7128): 382–85.

Hemingway, H., M. Stafford, S. Stansfeld, M. Shipley, and M. Marmot. 1997. "Is the SF-36 a Valid Measure of Change in Population Health? Results from the Whitehall II Study." *British Medical Journal 315 (7118): 1273–79.*

Idler, E. L., and Y. Benyamini. 1997. "Self-rated Health and Mortality: A Review of Twenty-seven Community Studies." *Journal of Health and Social Behavior 38 (1): 21–37.*

Kaplan, G. A., D. E. Goldberg, S. A. Everson, R. D. Cohen, R. Salonen, J. Tuomilehto, and J. T. Salonen. 1996. "Perceived Health Status and Morbidity and Mortality: Evidence from the Kuopio Ischaemic Heart Disease Risk Factor Study." *International Journal of Epidemiology 25 (2): 259–65.*

Kaplan, G. A., E. R. Pamuk, J. W. Lynch, R. D. Cohen, and J. L. Balfour. 1996. "Inequality in Income and Mortality in the United States: Analysis of Mortality and Potential Pathways." *British Medical Journal* 312 (7037): 999–1003.

Kennedy, B. P., I. Kawachi, and D. Prothrow-Stith. 1996. "Income Distribution and Mortality: Cross-Sectional Econological Study of the Robin Hood Index in the United States." *British Medical Journal* 312 (7037): 1004–1007.

Kennedy, B. P., I. Kawachi, R. Glass, and D. Prothrow-Stith. 1998. "Income Distribution, Socioeconomic Status, and Self-rated Health in the United States: Multilevel Analysis." *British Medical Journal* 317 (7163): 917–21.

Korten, A. E., A. F. Jorm, J. L. Letenneur, P. A. Jacomb, A. S. Henderson, H. Christensen, and B. Rodgers. 1999. "Health, Cognitive, and Psychosocial Factors as Predictors of Mortality in an Elderly Community Sample." *Journal of Epidemiology and Community Health* 53 (2): 83–88.

Lantz, P. M., J. S. House, J. M. Lepkowski, D. R. Williams, R. P. Mero, and J. Chen. 1999. "Socioeconomic Factors, Health Behaviors, and Mortality: Results from a Nationally Representative Prospective Study of U.S. Adults." *Journal of the American Medical Association* 279 (21): 1703–708.

LeGrand, J. 1987. "Inequalities in Health: Some International Comparisons." *European Economic Review* 31: 182–91.

Lochner, K., E. Pamuk, D. Makuc, B. P. Kennedy, and I. Kawachi. 1999. "State Income Inequality and Individual Mortality Risk: A Prospective Multi-level Study." *American Journal of Epidemiology* 149 (Supplement): S23 (Abstract).

Lynch, J. W., and G. A. Kaplan. 1997. "Understanding How Inequality in the Distribution of Income Affects Health." *Journal of Health Psychology* 2 (3): 197–314.

Lynch, J. W., G. A. Kaplan, E. R. Pamuk, R. D. Cohen, K. E. Heck, J. L. Balfour, and J. H. Yen. 1998. "Income Inequality and Mortality in Metropolitan Areas of the United States." *American Journal of Public Health* 88 (7): 1074–80.

Madans, J. H., C. S. Cox, J. C. Kleinman, D. Makuc, J. J. Feldman, F. F. Finacane, J. H. Barbano, and J. Cornoni-Huntley. 1986. "10 Years after NHANES I: Mortality Experience at Initial Followup, 1982–84." *Public Health Reports, Hyattsville* 101 (5): 474–81.

Mellor, J. M., and J. Milyo. 1999. "Income Inequality and Health Status in the United States: Evidence from the Current Population Survey," No. 8, RWJ Scholars in Health Policy Working Paper Series. Boston: Robert Wood Johnson Foundation.

Miller, H. W. 1977. "Plan and Operation of the Health and Nutrition Examination Survey, United States, 1971–73." *Vital and Health Statistics,* Series 1, No. 10a, 10b. DHEW Pub. No. (PHS) 73–1310. Washington, DC: Government Printing Office.

Morgenstern, H. 1995. "Ecologic Studies in Epidemiology: Concepts, Principles, and Methods." *Annual Review of Public Health* 16: 61–81.

Research Triangle Institute. 1991. *SUDAAN: Professional Software for SUrvey DAta ANalysis.* Research Triangle Park, NC.

Rodgers, G. B. 1979. "Income and Inequality as Determinants of Mortality: An International Cross-section Analysis." *Population Studies* 33: 343–51.

Smith, G. D. 1996. "Income Inequality and Mortality: Why Are They Related?" *British Medical Journal* 312 (7037): 987–88.

Soobader, M., and F. B. LeClere. 1999. "Aggregation and the Measurement of Income Inequality: Effects on Morbidity." *Social Science and Medicine* 48 (6): 733–44.

Sorlie, P. D., E. Backlund, and J. B. Keller. 1995. "U.S. Mortality by Economic, Demographic, and Social Characteristics: The National Longitudinal Mortality Study." *American Journal of Public Health* 85 (7): 949–56.

Ware, J. E., Jr. 1995. "The Status of Health Assessment 1994." *Annual Review of Public Health* 16: 327–54.

Wilkinson, R. G. 1997a. "Commentary: Income Inequality Summarises the Health Burden of Individual Relative Deprivation." *British Medical Journal* 314 (7096): 1727–28.

———. 1997b. "Health Inequalities: Relative or Absolute Material Standards." *British Medical Journal* 314 (7080): 591–95.

———. 1996. *Unhealthy Societies: The Afflictions of Inequality.* London: Routledge.