Socioeconomic Factors, Health Behaviors, and Mortality

Results From a Nationally Representative Prospective Study of US Adults

Paula M. Lantz, PhD; James S. House, PhD; James M. Lepkowski, PhD; David R. Williams, PhD; Richard P. Mero, MS; Jieming Chen, PhD

Context.—A prominent hypothesis regarding social inequalities in mortality is that the elevated risk among the socioeconomically disadvantaged is largely due to the higher prevalence of health risk behaviors among those with lower levels of education and income.

Objective.—To investigate the degree to which 4 behavioral risk factors (cigarette smoking, alcohol drinking, sedentary lifestyle, and relative body weight) explain the observed association between socioeconomic characteristics and all-cause mortality.

Design.—Longitudinal survey study investigating the impact of education, income, and health behaviors on the risk of dying within the next 7.5 years.

Participants.—A nationally representative sample of 3617 adult women and men participating in the Americans' Changing Lives survey.

Main Outcome Measure.—All-cause mortality verified through the National Death Index and death certificate reviews.

Results.—Educational differences in mortality were explained in full by the strong association between education and income. Controlling for age, sex, race, urbanicity, and education, the hazard rate ratio of mortality was 3.22 (95% confidence interval [CI], 2.01-5.16) for those in the lowest-income group and 2.34 (95% CI, 1.49-3.67) for those in the middle-income group. When health risk behaviors were considered, the risk of dying was still significantly elevated for the lowest-income group (hazard rate ratio, 2.77; 95% CI, 1.74-4.42) and the middle-income group (hazard rate ratio, 2.14; 95% CI, 1.38-3.25).

Conclusion.—Although reducing the prevalence of health risk behaviors in low-income populations is an important public health goal, socioeconomic differences in mortality are due to a wider array of factors and, therefore, would persist even with improved health behaviors among the disadvantaged.

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OVER THE PAST several decades, health behavior or lifestyle factors—smoking cigarettes, being overweight, drinking alcoholic beverages, and being physically inactive or leading a sedentary lifestyle—have often been cited as the major determinants of premature and preventable morbidity and mortality.[1-7] More recently, differences in health outcomes by socioeconomic position have been recognized as a persisting and perhaps even increasing public health problem.[8-12] Less well understood, however, is the relationship between health risk behaviors and socioeconomic differentials in health, especially in nationally representative samples. In a number of longitudinal studies, important socioeconomic indicators—such as income and education—have been shown to be inversely associated with various mortality outcomes, including premature mortality, cardiovascular mortality, and death from all causes.[13-18] In addition, it is well documented that people of lower socioeconomic position are significantly more likely to lead a sedentary lifestyle, to be overweight, and to smoke cigarettes.[19-22] Thus, a prominent hypothesis is that the elevated mortality risk associated with low levels of income and education is primarily due to the higher prevalence of health risk behaviors among people who are poor and/or have low educational attainment.[3,23-25] However, previous efforts to explain socioeconomic differences in mortality in a variety of subpopulations have found that strong differences remain after controlling for major lifestyle risk factors.[16,18,26-29]

For editorial comment see p 1745.

There are some serious limitations in the samples of most prior prospective studies on the contribution of health risk behaviors to socioeconomic differences in mortality. Although population-based samples were used, the populations were generally confined to a limited geographic area, such as a single city, county, or small region of a country, and, in many cases, samples were urther restricted by including only males.[16,18,20,26-29] In addition, much previous work has not provided a careful analysis of 2 primary socioeconomic indicators—education and income—even though it is quite possible that the mechanisms by which income and education are related to health behaviors and/or mortality differ significantly.

The degree to which health behaviors explain or mediate the influence of socioeconomic factors on mortality has important ramifications for health policy. The research presented here attempts to bring greater clarity to this issue by addressing the following questions: (1) what is the relationship between the socioeconomic factors of education and income and health behaviors, such as cigarette smoking, body weight, consumption of alcoholic beverages, and physical activity; (2) what are

From the Survey Research Center (Drs Lantz, House, Lepkowski, and Williams and Mr Mero), the School of Public Health (Drs Lantz, House, and Lepkowski), and the Department of Sociology (Drs House, Williams, and Chen), University of Michigan, Ann Arbor. Dr Chen is now with the Department of Psychology and Sociology, Texas A&M University at Kingsville.

Reprints: Paula M. Lantz, PhD, Department of Health Management and Policy, School of Public Health, University of Michigan, 109 Observatory, Ann Arbor, MI 48109-2029 (e-mail: plantz@umich.edu).

the relative magnitudes of the effects of education, income, and health behaviors on all-cause mortality; and (3) to what extent do health behaviors explain education and income differences in mortality, and does this vary by age, race, or sex? Our approach uses a nationally representative, longitudinal sample that includes both men and women, considers the effects of income and education separately, and investigates demographic subgroup variation in the relationship between education, income, health behaviors, and mortality.

METHODS

Study Design and Sample

The data analyzed for this study are from the Americans' Changing Lives (ACL) longitudinal survey conducted by the University of Michigan Survey Research Center. A stratified, multistage area sample of noninstitutionalized persons 25 years of age or older living in the coterminous United States was selected for study over time. Persons aged 60 years and older and blacks were oversampled. Initial face-to-face interviews were conducted with 3617 persons in 1986, representing 70% of all sampled households and 68% of sampled individuals. Information on the independent variables being studied (as described below) was taken from the 1986 ACL wave 1 survey. Two subsequent waves were conducted in 1989 and 1994. Additional details on the ACL survey design and methods are provided elsewhere.[12,30]

Information on deaths among sample respondents from mid-1986 through March 1994 was obtained from informants and through the National Death Index. The main outcome variable is all-cause mortality. In addition, underlying causes of death (obtained from death certificates) were grouped into 4 categories based on the *International Statistical Classification of Diseases, 10th Revision* (*ICD-10*): (1) tumors, (2) cardiovascular diseases, (3) all other diseases, and (4) external causes, such as unintentional injury, suicide, homicide, or legal intervention. To date, 90.3% of all deaths have been verified with death certificates. Reports of the 9.7% of deaths (n = 53) not yet verified with death certificates were reviewed carefully, and actual death appears to be certain in each case. For these cases, the month and year of death were ascertained from information about the deaths obtained from informants.

Socioeconomic Factors and Other Sociodemographic Measures

The socioeconomic factors being studied are education and income, based on self-reported information from the ACL wave 1 survey. Education is measured as respondents' total years of completed education and is grouped as a 3-category classification: 0 through 11 years; 12 through 15 years; and 16 or more years. Income is measured as the combined income from all sources of the respondent and his or her spouse in the preceding year, and also is grouped into 3 categories: $0 through $9999; $10 000 through $29 999; and $30 000 or more. More refined categories of education and income produced similar results for the analyses presented, as did adding controls for household size and assets.

Age is grouped into 6 categories: 25 through 34 years; 35 through 44 years; 45 through 54 years; 55 through 64 years; 65 through 74 years; and 75 years or older. Other sociodemographic variables being studied include sex (male vs female), race (nonblack vs black), and urbanicity of residence (central city, suburban, or rural). Previous research has found these demographic variables to be related to socioeconomic factors, health risk behaviors, and mortality. Thus, they are included in the analysis primarily as controls for potential confounders.

Behavioral Risk Factor Measures

Health behavior indicators are based on self-reported information from respondents at ACL wave 1. Cigarette smoking is coded as never smoked, former smokers, and current smokers. Alcohol drinking is coded using 3 categories based on the number of drinks consumed in the past month: nondrinkers (0 alcoholic drinks in past month), moderate drinkers (1-89 drinks), and heavy drinkers (≥90 drinks). Body weight was measured using the body mass index (BMI), weight in kilograms divided by the square of height in meters , based on self-reported weight and height. The body weight variable was coded as normal body weight, overweight, and underweight. Following the methods of Berkman and Breslow,[1] those in the highest 15% of the weighted sex-specific BMI distributions were coded as overweight and those in the lowest 5% of the weighted sex-specific BMI distributions were coded as underweight.

A physical activity index was computed based on answers to questions regarding how often the respondent engaged in active sports or exercise, gardening or yard work, and taking walks. Physical activity index scores were divided into quintiles to create 5 groupings of near-equal sample size. The group in the top quintile represents the 21% of the weighted sample that is the most physically active.

Health Status.—Three variables were available to measure baseline health status: (1) self-rated health measured with a single 5-category scale classified as excellent, very good, good, fair, and poor; (2) the number of major chronic conditions experienced in the last year from a list of 10 conditions; and (3) an index of functional status, with the lowest score of 1 representing confinement to a chair or bed and the highest score of 4 representing the ability to do heavy work inside or outside the house.[30]

Statistical Analysis.—In all analyses, the data were weighted to adjust for differential response rates and variation in probabilities of selection into the sample. Poststratification weights adjust ACL wave 1 sample results to the July 1, 1986, Bureau of the Census population estimates by sex, age, and region of the country. Descriptive statistics were obtained through the Statistical Analysis System, SAS Institute, Inc, Cary, NC, including frequency distributions of all variables being studied, cross tabulations of the socioeconomic variables and health risk behaviors, and cross tabulations of socioeconomic variables and mortality. In creating contingency tables regarding the relationship between socioeconomic factors and health risk behaviors, direct standardization to the age distribution of the weighted ACL wave 1 population was used to account for the strong association between age and socioeconomic factors.[31]

The Cox proportional hazards model was used to estimate the relative risk of mortality in terms of various background, socioeconomic, and health behavior variables. Taylor series linearization procedures using SUDAAN, Research Triangle Institute, Research Triangle Park, NC, were used to make adjustments to standard errors for the complex sample design. The effects of each independent variable being studied on mortality were analyzed separately. A series of multiple predictor models were then estimated. First, the relative hazard rate of mortality was estimated for income and education groups both separately and together, controlling for age, sex, race, and urbanicity. Second, the behavioral risk factors being studied were added to the base model to investigate how much of the socioeconomic differentials in mortality could be attributed to these factors. Models were also run in which controls for baseline health status were added and in which possible interactive effects between health behaviors and variables such as education, income, sex, and race were explored.

RESULTS

A significant portion of sample respondents (representing the national population) were socioeconomically dis-

advantaged (Table 1). A total of 25.6% of the weighted sample reported 0 to 11 years of education, and 19.2% reported annual incomes of less than $10 000 at ACL wave 1. A total of 546 respondents (15.1% of the overall sample and 9.9% of the weighted sample) died during the 7.5-year follow-up period. The deaths included 255 males and 291 females, 338 nonblacks and 208 blacks, and 147 persons younger than 65 years and 399 persons aged 65 years and older.

The distribution of the 4 behavioral risk factors being studied significantly varied by educational attainment and annual household income, adjusting for age (Table 2). For example, persons with the least amount of education and with the lowest incomes were significantly more likely to be current smokers, overweight, and in the lowest quintile for physical activity. Additional analyses suggest that there was a high degree of stability in individuals' health behaviors across ACL study waves. For example, of those who were overweight at wave 1, 84% were overweight at wave 2, and of those who were current smokers at wave 1, 79% were still smoking at wave 2.

Table 3 presents the hazard rate ratios of mortality by education and income for males and females separately. Those with low educational attainment were significantly more likely to die than those with 16 or more years of education. The relationship between education and mortality and between income and mortality was stronger for females. Both men and women in the lowest-income category were more than 3 times as likely to die during the follow-up period of the study than those in the highest group, controlling for age and other sociodemographic variables (Table 3). While education was strongly related to health behaviors, income was more predictive of mortality than education.

The relationship between socioeconomic factors, health behaviors, and mortality was explored by conducting a sequence of Cox proportional hazards models. The results of a model including statistical controls for age, race, urbanicity, sex, education, and income are presented as model 1 in Table 4. The results show that the effect of income on mortality was strong and significant when controlling for educational attainment and background demographic variables. However, when these sociodemographic variables were considered simultaneously, the bivariate effect of education on mortality attenuated to a statistically insignificant level. Additional model testing (results not shown) demonstrated that the mechanism by which education was related to mortality was through its association with income.

Table 1.—Distribution of Study Variables in ACL Population*

Variable	Unweighted (Total N = 3617)	Unweighted, %	Weighted, %
Age, y			
25-34	740	20.5	29.0
35-44	591	16.3	23.2
45-54	390	10.8	14.6
55-64	685	18.9	13.8
65-74	765	21.2	12.5
≥75	446	12.3	7.0
Sex			
Male	1358	37.5	47.1
Female	2259	62.5	52.9
Race			
Nonblack	2243	67.5	89.0
Black	1174	32.5	11.0
Residence			
City	1204	33.3	24.4
Suburban	1346	37.2	47.0
Other	1067	29.5	28.6
Education, y			
0-11	1349	37.3	25.6
12-15	1768	48.9	54.7
≥16	500	13.8	14.7
Income, $			
<10 000	1176	32.5	19.2
10 000-29 999	1475	40.8	40.5
≥30 000	966	26.7	40.3
Smoking			
Current	1060	29.3	30.4
Past	941	26.0	27.5
Never	1616	44.7	42.1
Alcohol drinks in past month			
None	1837	50.8	41.2
Moderate	1650	45.6	54.5
High	130	3.6	4.3
Body mass index†			
Overweight	679	18.8	15.3
Normal	2752	76.1	79.6
Underweight	186	5.1	5.1
Physical activity			
Quintile 1 (low)	1037	28.7	21.3
Quintile 2	540	14.9	14.9
Quintile 3	952	26.3	27.4
Quintile 4	439	12.1	15.2
Quintile 5 (high)	649	17.9	21.3
Mortality			
Alive	3071	84.9	90.1
Dead	546	15.1	9.9

*ACL indicates Americans' Changing Lives.
†Body mass index is a measure of weight in kilograms divided by the square of height in meters.

When the 4 health behaviors being studied were added individually to model 1 (results not shown), the effect of income on mortality attenuated slightly yet remained significant for both the lowest-income and the middle-income groups. For example, when physical activity was added to the model, the coefficient for the effect of income attenuated a small amount, suggesting that physical activity explains only a small proportion of the relationship between income and mortality. The results of the full model when all health behaviors were considered simultaneously (model 2, Table 4) show that there was still a strong and significant income effect on mortality for both the middle-income (odds ratio [OR] = 2.14; CI, 1.38-3.25) and the low-income groups (OR = 2.77; CI, 1.74-4.42). The 4 health behaviors together accounted for 12% to 13% of the predictive effect of income on mortality.

In terms of the health behaviors, the results suggest that being severely underweight or having lower levels of physical activity were significant risk factors for subsequent mortality, controlling for demographic and socioeconomic characteristics (Table 4). The relationship between physical activity and mortality appeared to be monotonic, suggesting that there are gains not only from being physically active but also from increasing

Table 2.—Age-Adjusted Prevalence of Health Risk Behaviors by Socioeconomic Factors in ACL Population*

Factors	Education, y			Income, $		
	0-11	12-15	≥16	<10 000	10 000-29 999	≥30 000
Smoking, %						
Current	42.0	33.1	19.6	37.7	34.2	27.4
Former	22.4	25.0	26.5	20.4	25.3	28.3
Never	35.6	41.9	53.9	41.9	40.5	44.3
	100	100	100	100	100	100
	$\chi^2_4 = 134.6$ ($P<.001$)			$\chi^2_4 = 30.86$ ($P<.001$)		
Alcohol drinks in past month, %						
None	58.0	42.0	33.0	59.3	46.0	31.3
1-89	37.6	54.0	63.3	37.2	50.3	64.2
≥90	4.4	4.0	3.7	3.5	3.7	4.5
	100	100	100	100	100	100
	$\chi^2_4 = 139.2$ ($P<.001$)			$\chi^2_4 = 159.1$ ($P<.001$)		
Body mass index, %†						
Underweight	5.4	5.7	4.2	6.4	5.9	3.7
Normal	67.1	78.9	84.7	69.2	76.1	82.3
Overweight	27.5	15.4	11.1	24.4	18.0	14.0
	100	100	100	100	100	100
	$\chi^2_4 = 103.8$ ($P<.001$)			$\chi^2_4 = 48.2$ ($P<.001$)		
Physical activity, %						
Quintile 1 (low)	37.3	22.1	13.6	33.7	25.5	14.7
Quintile 2	14.3	15.0	16.6	14.0	15.7	15.3
Quintile 3	26.0	27.1	27.1	30.3	26.6	26.1
Quintile 4	9.1	14.6	16.7	9.3	13.2	17.3
Quintile 5	13.3	21.2	26.0	12.7	19.0	26.6
	100	100	100	100	100	100
	$\chi^2_4 = 301.63$ ($P<.001$)			$\chi^2_4 = 160.7$ ($P<.001$)		

*ACL indicates Americans' Changing Lives.
†Body mass index is a measure of weight in kilograms divided by the square of height in meters.

Table 3.—Sex-Specific Hazard Rate Ratios of Mortality by Socioeconomic Factors*

Factors	Male (n = 1358)		Female (n = 2259)	
	Age-Adjusted Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)	Age-Adjusted Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Education, y				
0-11	1.60 (1.08-2.36)	1.51 (0.99-2.29)	2.54 (1.25-5.16)	2.46 (1.14-5.0)
12-15	1.20 (0.81-1.23)	1.19 (0.97-1.75)	1.73 (0.79-3.78)	1.75 (0.80-3.82)
≥16	1.0	1.0	1.0	1.0
Income, $				
<10 000	3.32 (2.16-5.10)	3.13 (1.97-4.95)	3.90 (1.92-7.92)	3.82 (1.86-7.85)
10 000-29 999	2.27 (1.39-3.71)	2.34 (1.43-3.82)	2.64 (1.27-5.47)	2.64 (1.28-5.42)
≥30 000	1.0	1.0	1.0	1.0

*Multivariate odds ratios were adjusted for age, race, and urbanicity. CI indicates confidence interval.

amounts of activity. In regard to being underweight, descriptive information on the severely underweight individuals who died shows that the majority (78%) were age 75 years or older. Notably, the effects of smoking and drinking were no longer significant once they were adjusted for the demographic, socioeconomic, and other health behavior variables, and being overweight was not significant in any of the models.

It is plausible that baseline differences in both income and health behaviors reflect differences in health status to some degree. The 3 ACL wave 1 health status variables (self-reported health, number of chronic conditions, and functional status) were added separately and simultaneously to a model controlling for background characteristics, income, education, and health behaviors. The results (not shown) do not suggest any different patterns or effects from those shown in Table 4. The relationship between income and mortality remained strong and significant ($P<.001$) controlling for baseline health status and health behaviors simultaneously.

Additional analyses, including an examination of interaction tests, were conducted to see if the patterns and results observed for the full sample were the same across subpopulations of interest. Six subgroups were examined: males, females, nonblacks, blacks, persons ages 25 through 64 years, and persons ages 65 years and older. The results (not shown) did not reveal findings that were substantially different from those for the total sample. Overall, health behaviors explained only a small proportion of income differences in mortality across sex, race, and age groups.

For those descendents with death certificate information (n = 493), the weighted underlying cause of death was tumors, 30%, cardiovascular disease, 28%, other diseases, 37%, and external causes, 5%. Controlling for income and other sociodemographic variables, education was not significantly related to any cause-of-death category. Those in the lowest-income group had significantly higher rates of tumor deaths and cardiovascular disease deaths, and those in the middle-income group had a significantly higher rate of tumor deaths. Several health behaviors were associated with a significantly higher risk of death in specific categories (ie, both current and former smoking was associated with an increased risk of tumor deaths, heavy drinking was associated with increased risk of death from external causes, and low physical activity was associated with increased risk of tumor and cardiovascular deaths). However, for both tumor and cardiovascular disease deaths separately, controlling for health behaviors attenuated the association between low and moderate income with mortality to the same degree observed for death from all causes. The income effects decreased by 12% to 17% when health risk behaviors were added to the models, similar to what was observed in analyses where all causes of death were grouped together.

COMMENT

The ACL survey findings show that lower levels of education and income are associated with a significantly higher prevalence of health risk behaviors, including smoking, being overweight, and physical inactivity. The results also show that lower income (net of demographic characteristics) leads to a significant increase in mortality risk, yet the influence of major health risk behaviors explains only a modest proportion of this relationship.

Our findings of strong socioeconomic differences in mortality (including larger socioeconomic differentials for women than men, and a stronger mortality effect for income than for education for both women and men) are consistent with previous longitudinal research.[13-18] In addition, our findings regarding the association between socioeconomic factors, health behaviors, and mortality are similar to previous studies conducted using limited samples. For example, in a 20-year study of Ontario males, Hirdes and Forbes[6] concluded that smoking and other health practices are not the primary mechanisms linking socioeconomic status and mortality. Similarly, the Alameda County Study[28]

showed that the risk of mortality associated with living in high-poverty areas of Oakland, Calif, changed little after adjusting for smoking, alcohol consumption, physical activity, BMI, and sleep patterns. Our results contribute to previous studies by providing evidence regarding the association between education, income, health behaviors, and mortality from a nationally representative sample that includes both men and women.

While there appears to be little debate regarding the need to improve the health of populations with low levels of income and education, the appropriate focus of policy and program responses is less clear. An important area on which both policy rhetoric and action have focused is that of health education and health promotion at the individual level. A tacit assumption among some policymakers and health authorities is that an important way to reduce socioeconomic gaps in health status is to improve the health behaviors among those with low levels of income and education. This position is obvious in the Department of Health and Human Services' *Healthy People 2000: National Health Promotion and Disease Prevention Objectives* and other reports on the state of health among poor and minority persons in the United States.[2,3,23-25] This position has also been articulated in the lay press. For example, an opinion piece in the *Wall Street Journal*[32] criticized public health researchers' growing focus on social systems and institutions, arguing that poor people tend to have worse health and shorter life expectancies, primarily "because unhealthy habits are more prevalent on the lower rungs of the socioeconomic ladder."

Our results suggest that despite the presence of significant socioeconomic differentials in health behaviors, these differences account for only a modest proportion of social inequalities in overall mortality. Thus, public health policies and interventions that exclusively focus on individual risk behaviors have limited potential for reducing socioeconomic disparities in mortality. While reducing the prevalence of behavioral risk factors is an important and critical public health goal, socioeconomic differentials in mortality are due to a wider array of factors and, therefore, would persist even with improved health behaviors. Increasing health promotion and disease prevention efforts among the disadvantaged is not a "magic policy bullet" for reducing persistent socioeconomic disparities in mortality.

If health risk behaviors do not explain much of the relationship between socioeconomic factors and mortality, what else can account for this strong association? First, differences in exposure to occupational and environmental health hazards across social strata do exist and, thus, may be playing a role in mortality inequalities.[33-35] Second, although not a panacea for eliminating socioeconomic differences in health status, improved equity regarding access to and use of preventive and appropriate therapeutic medical care is viewed as having some potential for preventing the further deterioration of health in disadvantaged populations.[8,23,25,36-40]

Third, socioeconomic stratification itself may be a social force that has deleterious health effects for those in the lower strata. As Blane[41] explains, socioeconomic inequalities in societies "structure the life experiences of their members so that advantages and disadvantages tend to cluster cross-sectionally and accumulate longitudinally." Persons in lower socioeconomic strata have increased exposure to a broad range of psychosocial variables predictive of morbidity and mortality. This includes (1) a lack of social relationships and social supports; (2) personality dispositions, such as a lost sense of mastery, optimism, sense of control, and self-esteem or heightened levels of anger and hostility; and (3) chronic and acute stress in life and work, including the stress of racism, classism, and other phenomena related to the social distribution of power and resources.[25,30,34,42-45] Furthermore, Lynch et al[46] report that both the psychosocial orientations and health risk behaviors of adults are more common among those whose parents were poor when they were children. Thus, many individual characteristics, such as personality factors, psychosocial attitudes and

Table 4.—Mortality Hazard Rate Ratios From Explanatory Models*

Variable	Model 1 Hazard Rate Ratio (95% CI)	Model 2 Hazard Rate Ratio (95% CI)
Age, y		
25-34	1.0	1.0
35-44	2.72 (1.15-6.42)	2.66 (1.11-6.37)
45-54	3.71 (1.28-10.70)	3.46 (1.20-9.95)
55-64	9.87 (4.76-20.49)	9.30 (4.53-19.10)
65-74	17.64 (8.50-36.60)	16.78 (8.17-34.47)
≥75	47.47 (22.70-99.50)	40.00 (19.1-83.93)
Sex		
Male	1.0	1.0
Female	0.44 (0.33-0.57)	0.41 (0.30-0.54)
Race		
Nonblack	1.0	1.0
Black	1.21 (0.94-1.55)	1.19 (0.92-1.48)
Residence		
Rural	1.0	1.0
Suburban	1.19 (0.92-1.52)	1.16 (0.91-1.48)
City	1.63 (1.17-2.27)	1.52 (1.10-2.10)
Education, y		
≥16	1.0	1.0
12-15	1.06 (0.73-1.54)	0.95 (0.61-1.32)
0-11	1.08 (0.76-1.54)	0.90 (0.62-1.46)
Income, $		
≥30 000	1.0	1.0
10 000-29 999	2.34 (1.49-3.67)	2.14 (1.38-3.25)
<10 000	3.22 (2.01-5.16)	2.77 (1.74-4.42)
Smoking		
Never	. . .	1.0
Current	. . .	1.26 (0.93-1.69)
Former	. . .	1.28 (0.95-1.74)
Alcohol drinks in past month		
Moderate	. . .	1.0
None	. . .	1.13 (0.88-1.44)
Heavy		0.85 (0.46-1.59)
Body mass index†		
Normal	. . .	1.0
Underweight	. . .	2.03 (1.32-3.12)
Overweight	. . .	0.94 (0.72-1.23)
Physical activity		
Quintile 5 (high)	. . .	1.0
Quintile 4	. . .	1.46 (0.87-2.45)
Quintile 3	. . .	1.60 (1.04-2.47)
Quintile 2	. . .	2.25 (1.41-3.58)
Quintile 1 (low)	. . .	2.91 (1.94-4.56)

*CI indicates confidence interval; ellipses, data not applicable.
†Body mass index is a measure of weight in kilograms divided by the square of height in meters.

orientations, and health risk behaviors, should be viewed as products of or responses to social environments (eg, family, school, neighborhood, cultural context, etc) rather than strictly as individual behavioral choices.[47]

There are a number of limitations in our study methods. First, the health behaviors being investigated were self-reported and were not assessed retrospectively. Literature on the accuracy of self-reported health behaviors suggests that, although most people report honestly for behaviors that are not illegal, the biases that do exist are in the direction of underreporting negative health behaviors.[48-50] Thus, the result of any problems in the reporting of health behaviors would likely be an underestimation of their effects. Second, the length of the follow-up period in this prospective study limits our ability to investigate the longer-term effects of income, education, and health behaviors on mortality. Third, the small number of deaths for some of the demographic groups puts limits on the multivariate subgroup analysis that could be performed. Fourth, it is possible that additional health behaviors and risk factors not studied explain more of the relationship between income and mortality. Lynch et al[26] report that, in a longitudinal study of Finnish men, the association between socioeconomic status and mortality from all causes and from cardiovascular disease was eliminated by simultaneous adjustment for biologic factors, psychosocial factors, and health risk behaviors. A full explanation of social inequalities in mortality, however, needs to address why all of these risk factors tend to be patterned by socioeconomic characteristics.

Our results suggest that both health behaviors and socioeconomic factors are important determinants of mortality. While health behaviors are related to both income and education, they account for a small proportion of observed socioeconomic differences in mortality. Thus, the problem of lifestyle and mortality is not just one of inadequate education or income, and the problem of socioeconomic differentials in mortality is not just a problem of lifestyle choices. We must look to a broader range of explanatory risk factors, including structural elements of inequality in our society.

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References

1. Berkman LF, Breslow L. *Health and Ways of Living*. New York, NY: Oxford University Press; 1983.
2. US Department of Health and Human Services. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. Washington, DC: US Dept of Health and Human Services; 1990. DHHS publication 91-50212.
3. McGinnis MJ, Foege WH. Actual causes of death in the United States. *JAMA*. 1993;270:2207-2212.
4. Wiley JA, Camacho TC. Life-style and future health: evidence from the Alameda County Study. *Prev Med*. 1980;9:1-21.
5. Wilson PS. Established risk factors and coronary artery disease: the Framingham Study. *Am J Hypertens*. 1994;7(pt 2):75-125.
6. Hirdes JP, Forbes WF. The importance of social relationships, socioeconomic status and health practices with respect to mortality among Ontario males. *J Clin Epidemiol*. 1992;554:175-182.
7. Patterson RE, Haines PS, Pokin BM. Health lifestyle patterns of US adults. *Prev Med*. 1994;23:453-460.
8. Adler NE, Boyce WT, Chesney MA, Folkman S, Syme LS. Socioeconomic inequalities in health: no easy solution. *JAMA*. 1993;269:3140-3145.
9. Marmot MG, Kogevinas M, Elston MA. Social/economic status and disease. *Annu Rev Public Health*. 1987;8:111-135.
10. Pappas G, Queen S, Hadden W, Fisher G. The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. *N Engl J Med*. 1993;329:103-109.
11. Elo IT, Preston SH. Educational differences in mortality: United States, 1979-85. *Soc Sci Med*. 1996; 42:47-57.
12. House JS, Kessler RC, Herzog AR, et al. Age, socioeconomic status and health. *Milbank Q*. 1990; 68:383-411.
13. Stevenson THC. The social distribution of mortality from different causes in England and Wales, 1910-12. *Biometrika*. 1923;15:382-400.
14. Marmot MG, Shipley MJ, Rose G. Inequalities in death—specific explanations of a general patterns? *Lancet*. 1984;1:1003-1006.
15. Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic and social characteristics: the National Longitudinal Mortality Study. *Am J Public Health*. 1995;85:949-956.
16. Salonen JT. Socioeconomic status and risk of cancer, cerebral stroke and death due to coronary heart disease and any disease: a longitudinal study in eastern Finland. *J Epidemiol Community Health*. 1982;36:294-297.
17. Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation*. 1993;88:1973-1998.
18. Davey Smith G, Shipley MJ, Rose G. Magnitude and causes of socioeconomic differentials in mortality: further evidence from the Whitehall Study. *J Epidemiol Community Health*. 1990;44:265-270.
19. Winkleby MA, Fortmann SP, Barrett DC. Social class disparities in risk factors for disease: eight-year prevalence patterns by level of education. *Prev Med*. 1990;19:1-12.
20. Osler M. Social class and health behavior in Danish adults: a longitudinal study. *Public Health*. 1993; 107:251-260.
21. Wagenknecht LE, Perkins LL, Cutler GR, et al. Cigarette smoking is strongly related to educational status: the CARDIA Study. *Prev Med*. 1990;19:158-169.
22. Liu K, Cedres LB, Stamler J, et al. Relationship of education to major risk factors and death from coronary heart disease, cardiovascular diseases, and all causes. *Circulation*. 1982;66:1308-1314.
23. Krieger N, Rowley DL, Herman AA, Avery B, Phillips MT. Racism, sexism and social class: implications for studies of health, disease and well-being. *Am J Prev Med*. 1993;9(suppl):82-122.
24. Mechanic D. Socioeconomic status and health: an explanation of underlying processes. In: Bunker JP, Gomby DS, Kehrer BH, eds. *Pathways to Health: The Role of Social Factors*. Menlo Park, Calif: Henry J Kaiser Family Foundation; 1989:9-26.
25. Williams DR. Socioeconomic differentials in health: a review and redirection. *Soc Psychol Q*. 1990;53:81-99.
26. Lynch JW, Kaplan GA, Cohen RD, et al. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction? *Am J Epidemiol*. 1996;144:934-942.
27. Rose G, Marmot MG. Social class and coronary heart disease. *Br Heart J*. 1981;45:13-19.
28. Haan M, Kaplan G, Camacho T. Poverty and health: prospective evidence from the Alameda County Study. *Am J Epidemiol*. 1987;125:989-998.
29. Duijkers TJ, Kromhout D, Spruit IP, Doornbos G. Intermediary risk factors in the relation between socioeconomic status and 25-year mortality (the Zutphen Study). *Int J Epidemiol*. 1989;18:658-662.
30. House JS, Lepkowski JM, Kinney AN, Mero RP, et al. The social stratification of aging and health. *J Health Soc Behav*. 1994;35:213-234.
31. Shyrock HS. *The Methods and Materials of Demography*. Orlando, Fla: Academic Press Inc; 1976.
32. Satel S. The politicization of public health. *Wall Street Journal*. December 12, 1996;editorial section: 12.
33. Antonosky A. Social class, life expectancy and overall mortality. *Milbank Q*. 1967;45:31-73.
34. Williams DR, Collins C. US socioeconomic and racial differences in health: patterns and explanations. *Annu Rev Sociol*. 1995;21:349-386.
35. Moore ME, Hayward MD. Occupational careers and mortality of elderly men. *Demography*. 1990;27: 31-53.
36. Riessman CK. The use of health services by the poor. *Soc Policy*. 1974;5:41-49.
37. Dutton DB. Explaining the low use of health services by the poor: costs, attitudes or delivery systems? *Am Soc Rev*. 1978;43:348-368.
38. Lantz PM, Weigers ME, House JS. Education and income differentials in breast and cervical cancer screening: policy implications for rural women. *Med Care*. 1997;35:219-236.
39. Blendon R, Aiken L, Freeman H, Corey C. Access to medical care for black and white Americans. *JAMA*. 1989;261:278-281.
40. Woolhandler S, Himmelstein DU, Silber R, Bader M, et al. Medical care and mortality: racial differences in preventable deaths. *Int J Health Serv*. 1985;15:1-11.
41. Blane D. Social determinants of health—socioeconomic status, social class and ethnicity. *Am J Public Health*. 1995;85:903-905.
42. House JS, Williams DR. *NHLBI Report of the Conference on Socioeconomic Status and Cardiovascular Health and Disease: Psychosocial Pathways Linking SES and CVD*. Bethesda, Md: National Institutes of Health; 1995:119-124.
43. Rodin J. Aging and health: effects of the sense of control. *Science*. 1986;233:1271-1276.
44. Kessler RC, Neighbors HW. A new perspective on the relationship between race, social class and psychological distress. *J Health Soc Behav*. 1986;27: 107-115.
45. Kaplan G, Pamuk E, Lynch JW, Cohen RD, Balfour JL. Inequality in income and mortality in the United States: analysis of mortality and potential pathways. *BMJ*. 1996;312:999-1003.
46. Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? variation in adult health behaviors and psychosocial characteristics by stages of the socioeconomic lifecourse. *Soc Sci Med*. 1997; 6:809-819.
47. Mirowsky J, Ross CE. *Social Causes of Distress*. New York, NY: Aldine de Gruyter; 1989.
48. Baranowski T. Methodologic issues in self-report of health behavior. *J Sch Health*. 1985;55:179-182.
49. Cohen BB, Vinson DC. Retrospective self-report of alcohol consumption: test-retest reliability by telephone. *Alcohol Clin Exp Res*. 1995;19:1156-1161.
50. Durante R, Ainsworth BE. The recall of physical activity: using a cognitive model of the question-answering process. *Med Sci Sports Exerc*. 1996;28: 1282-1291.