Optimal Indicators of Socioeconomic Status for Health Research

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Objectives. In this study we examined the relationship between indicators of socioeconomic status (SES) and mortality for a representative sample of individuals.

Methods. The sample included 3734 individuals aged 45 and older interviewed in 1984 in the Panel Study of Income Dynamics. In the current study, mortality was tracked between 1984 and 1994 and is related to SES indicators of education, occupation, income, and wealth.

Results. Wealth and recent family income were the indicators that were most strongly associated with subsequent mortality. These associations persisted after we controlled for the other SES indicators and were stronger for women than for men and for nonelderly than for elderly individuals.

Conclusions. We found that the economic indicators of SES were usually as strongly associated with mortality as, if not more strongly associated with mortality than, the more conventional indicators of completed schooling and occupation. (*Am J Public Health.* 2002;92:1151–1157)

Although numerous studies have documented the associations between socioeconomic status (SES) indicators and a variety of health outcomes,[1–6] comprehensive indicators of SES are not routinely collected in the United States. In addition, most SES data that are obtained are not reported.[7–9] This data deficiency was highlighted at a 1996 federally sponsored health conference on SES[1,10] and has been noted by the National Committee on Vital and Health Statistics.[11] In both cases, the recommendation was for regular collection of SES data and for the use of SES variables in studies of differential health outcomes.

Despite growing awareness of the need for regular collection of SES indicators, however, there is little agreement on which indicators should be gathered.[12] One problem is that numerous indicators of SES, including occupation,[13] education,[14,3] and household income,[4,5,15,16] have been shown to affect health outcomes, but these indicators are not interchangeable.[12,17–19] Moreover, the impact on health of any particular SES indicator—such as one based on sex and age—varies across different population subgroups.[3,20–22] The fact that various SES indicators may capture different aspects of overall health risk suggests that a systematic examination of the explanatory power of a variety of SES indicators is required before an optimal set of indicators can be recommended.

We contribute to this examination by analyzing the empirical relationship between a set of SES indicators (available from both administrative and survey data sources) and mortality for a nationally representative sample of individuals. We used a unique data set, the Panel Study of Income Dynamics (PSID), to evaluate the predictive power of a variety of SES indicators. Although it includes the traditional SES indicators of education and occupation, our analysis focuses on the relatively neglected economic indicators of SES.

In general, indicators of SES are meant to provide information about an individual's access to social and economic resources. As such, they are markers of social relationships and command over resources and skills that vary over time.[23–24] Among the most frequently used socioeconomic indicators are education and occupation. Economic indicators such as household income and wealth are used less frequently but are potentially as important as or more important than education and occupation. We describe the benefits and drawbacks of each indicator below.

Education is an important determinant of individuals' work and economic circumstances,[25] which are themselves linked to health through specific work conditions and levels of consumption. Education may also be associated with health through its connection to health behaviors. The higher one's level of education, the more likely one is to engage in a range of health-enhancing self-maintenance activities.[26,27] Years of completed schooling are reported with reasonable ease and reliability and are a meaningful indicator of SES for virtually all adults. Because education is typically completed early in adulthood, it serves as a marker of early life circumstances,[28] and no reverse-causation problems result from linking education with health outcomes at older ages. It is for these reasons that the National Center for Health Statistics (NCHS) selected education for inclusion in death certificates in 1989[7] and that the National Committee on Vital and Health Statistics has offered the preliminary assessment that education may be the most useful SES indicator for administrative databases.[11] However, education captures neither the differential on-the-job training and other career investments made by individuals with similar levels of formal schooling nor the volatility in economic status during adulthood that has recently been shown to adversely affect health.[16]

Usual or most recent occupation has long been used as an SES indicator for persons in the workforce, and it can have direct and indirect effects on health. For example, occupation represents exposure to the psychosocial and physical dimensions of work arrangements[29,30] as well as a range of expected earnings and social capital in the form of relative standing or prestige. Indicators of occupational class are widely used in other industrialized countries and have been found to be robust in predicting variations in health status.[17] The National Institutes of Health (NIH) conference on Measuring Social Inequalities in Health called for including occupation as a core SES variable in the US health status re-

porting system.[1] Nevertheless, using occupation as an SES indicator is problematic for subgroups such as teenaged mothers and others with little labor market experience. Moreover, later-career occupations, unlike education, are subject to reverse-causation problems if poor health leads to declines in occupational status.

Household income has been more widely used as an indicator of SES in US studies than in studies undertaken elsewhere. Whereas education and occupation capture individually based dimensions of SES, household income is more indicative of a standard of living and of life chances household members experience through sharing goods and services. The most typical income-based indicator is a household's total cash income, measured over the month, calendar year, or 12-month period before the point of health measurement.[5,15,22] Our examination of "optimal" SES indicators was decidedly empirical and was based on the indicators' sensitivity to mortality risk. We find that economic indicators are considerably more sensitive than traditional ones and suggest that the former should be a standard feature of the US measurement system for monitoring links between SES and health. Although they require difficult-to-obtain tax data, measures of disposable household income—obtained by subtracting from total cash income the taxes households pay—better approximate a household's flow of resources than do measures of total cash income.

One problem with using household income to examine relationships between SES and health is that household members may have unequal access to household income. Specifically, research points to a female disadvantage in resource sharing in households.[31,32] A second problem is that current household income may be an inadequate representation of the standard of living of retired individuals because it may not reflect available financial resources, and it disregards the cumulative effects of a lifetime of deprivation or privilege.[33] Moreover, because current income may be a product of recent health, associations between income and health are subject to reverse-causation problems.

In contrast to income, which consists of a flow of resources over a defined time period, wealth captures the accumulated stock of assets or economic reserves at a given point in time. Income and wealth are positively correlated. For example, wealth is higher for families with histories of higher earnings, lower consumption, more savings and, in some cases, fewer expenditures on health care. But wealth and income are also distinct. For example, elderly individuals frequently have little income but substantial wealth. For most of the US population, wealth is tied up in cars and homes, items for which survey nonresponse bias can be minimized. Several studies in both the United States and the United Kingdom have found that indicators of wealth are related to health, independent of the more traditional indicators of SES.[33–36] Concurrent associations between wealth and health are subject to problems of reverse causation, although perhaps less so than are concurrent associations between income and health, given that accumulating wealth typically takes a long time.

Most health inequalities research undertaken in the United States relies on SES ascertained at a single point in time. Although this measure provides some indication of the relative pattern of health differentials, the cumulative and dynamic nature of socioeconomic structures and experiences is rarely considered. Persistent low income and income volatility may be especially problematic for health,[16] and degree of vulnerability to socioeconomic conditions may vary across the life course.[37] Thus, in assessing the relevance of cross-sectional and longitudinal measures of SES for public policy regarding data collection and reporting, it is important to evaluate the relative utility of these measures.

Finally, although cumulative research points to a robust association between SES and health, the magnitude of the effect of SES on health may vary across social groups. For example, a weaker socioeconomic gradient in mortality has been observed for retired individuals[21,38] and women.[24,39,40] The survival of those with lower levels of health risk, the postponement of morbidity among the socioeconomically advantaged, the universality of certain social programs (e.g., Medicare), and the inadequacy of commonly used indicators of SES to capture the experiences of diverse groups may account for the differential effects of SES by age,[20,41] race/ethnicity,[42,43] and sex.[44]

With a view to providing concrete information that could lead to routinizing the gathering of socioeconomic information in various data-collection modes, we examined the relationship between SES and mortality using data from the PSID. We considered both individual and household indicators of SES as well as the relative merit of short-term vs long-term appraisal of selected indicators. All analyses were stratified by age and sex. Insufficient case counts precluded an additional level of stratification by race/ethnicity.

METHODS

Data

The PSID is an ongoing longitudinal study of a representative sample of individuals living in the United States and of the family units in which they reside. The survey began in 1968 with the most recent mortality follow-up through 1994. The emphasis of the survey is on dynamic aspects of household economic and demographic characteristics, and study staff have been careful to edit and code occupation, earnings, and family income data consistently across waves. Beginning with a representative national sample of households and individuals in 1968, the PSID has collected data on individuals from those households on an annual basis. The initial-wave response rate among sampled dwellings in 1968 was 76%. Attrition was 11% between 1968 and 1969 and has remained between 2% and 3% for each year since 1969. Approximately 55% of the still-living original sample were still participating in the study in the interviewing year 1995. Studies evaluating the national representativeness of the surviving PSID sample at various points (including the 1984 point used to define our sample) have found no significant problems.[45] Probability-of-selection weights are available to adjust for differential nonresponse not related to mortality, as well as for the design-driven unequal selection probabilities of the original sample. This makes it possible to generate estimates that are representative of the US population (omitting some immigrants who arrived after 1968).

Death is recorded in the PSID as a reason for attrition from the sample. In the majority of instances, deaths are reported in the next annual interview by a surviving household member. For individuals who were living alone when last interviewed, information about death comes from a variety of sources, including a surviving contact person, the administrator of the deceased individual's estate, or the post office (via returned mail). Comparisons of PSID data with vital statistics mortality data from the NCHS generally show close agreement.

Sample

The analysis of PSID data is based on 3734 individuals aged 45 and older who participated in the 1984 interview. Deaths among these individuals were tracked between 1984 and 1994. Over this period 298 deaths (11.8%) were recorded for the nonelderly cohort (aged 45 through 64; 67.8% of the sample) and 535 deaths (44.3%) were recorded for the elderly cohort (aged 65 and older; 32.2% of the sample). Mortality was linked with SES indicators by means of Poisson regression models that included additive controls for age in 1984, race/ethnicity (Black vs all other), and sex. Although the relatively small sample available in the PSID precluded estimation of separate models for most demographic subgroups, we did estimate a complete set of models separately for nonelderly men and women (aged 64 years or younger in 1984; n=1091 and 1435, respectively). In all cases, we calculated Huber-White robust standard errors using Stata (version 6.0) to account for the geographically clustered nature of the sample.[46]

We distinguished three kinds of SES indicators: (1) administrative data indicators, which can be collected in most health data, including death and birth certificates; (2) survey indicators that can be collected in a household survey; and (3) exogenous indicators measured a decade or more before the measurement of the health outcome, which are likely free from the serious bias caused by health status affecting SES.

Administrative Data Indicators

Included in our set of readily collected SES indicators were years of completed schooling, most recent occupation, and total family income. Several of the PSID's interviewing waves included a direct question about completed schooling; we took the most recent report before the 1984 interview. Descriptive information about this and all other indicators is presented in Table 1.

The PSID asked for information about occupation whenever a respondent reported being employed at the time of the interview

TABLE 1—Descriptive Statistics for Analysis Variables[a]

	Age 45-64			Age ≥65
	Total	Men	Women	Total
Administrative Data Indicators				
Education				
N[b]	2526	1091	1435	1208
≤8 years	0.21 (0.411)	0.24 (0.425)	0.20 (0.399)	0.41 (0.493)
9-11 years	0.21 (0.409)	0.19 (0.395)	0.23 (0.418)	0.16 (0.371)
12 years	0.35 (0.478)	0.28 (0.451)	0.41 (0.491)	0.26 (0.439)
≥13 years	0.21 (0.410)	0.28 (0.449)	0.16 (0.370)	0.15 (0.358)
Last Occupation				
N[b]	2369	1075	1294	919
Farmer	0.02 (0.129)	0.03 (0.179)	na	0.02 (0.147)
Service	0.15 (0.359)	0.07 (0.258)	0.21 (0.410)	0.05 (0.209)
Laborer	0.03 (0.176)	0.06 (0.244)	0.01 (0.091)	0.02 (0.151)
Operative	0.17 (0.378)	0.16 (0.370)	0.18 (0.384)	0.23 (0.422)
Crafts	0.09 (0.292)	0.21 (0.405)	0.01 (0.087)	0.05 (0.227)
Sales	0.04 (0.193)	0.04 (0.196)	0.04 (0.19)	0.02 (0.139)
Clerical	0.13 (0.338)	0.05 (0.217)	0.19 (0.395)	0.09 (0.289)
Manager	0.10 (0.303)	0.16 (0.368)	0.06 (0.232)	0.04 (0.185)
Professional	0.09 (0.293)	0.12 (0.328)	0.07 (0.261)	0.06 (0.243)
1983 Pre-Tax Family Income				
N[b]	2526	1091	1435	1208
Overall Mean	34 233 (32 467)	39 715 (34 337)	30 065 (30 327)	19 252 (18 242)
Survey-Based Indicators				
Total Wealth				
N[b]	2526	1091	1435	1208
Overall Mean	118 356 (345 277)	135 801 (369 394)	105 093 (325 254)	114 855 (424 458)
1979-1983 Post-Tax Family Income				
N[b]	2526	1091	1435	1208
Overall Mean	29 040 (21 338)	32 644 (21 825)	26 301 (20 549)	19 289 (29 755)
1979-1983 Family Income-to-Needs				
N[b]	2526	1091	1435	1208
Overall Mean	3.7 (3.4)	4.2 (3.5)	3.4 (3.3)	3.0 (4.9)
"Exogenous" Indicators				
1969-1975 Post-Tax Family Income				
N[b]	2526	1091	1435	1208
Overall Mean	26 433 (14 480)	28 064 (14 177)	25 193 (14 590)	20 110 (14 181)
1969-1975 Family Income-to-Needs				
N[b]	2526	1091	1435	1208
Overall Mean	2.7 (1.9)	2.9 (1.9)	2.6 (2.0)	3.0 (2.5)

[a]Unweighted mean (standard deviation).
[b]Number of nonmissing observations on analysis variable.
Source: Authors' calculations based on the Panel Study of Income Dynamics.

or in the calendar year preceding it; again, we took the most recent report before the 1984 interview. Questions used to determine occupation were identical to those asked in Census Bureau surveys, and responses were coded to the 1970 US Census occupational classifications. The ordinal scale used in the inequality index method (discussed below) was based on the following ranking of occupations: professional, managerial, clerical, sales, crafts, operatives, laborers, service, and farmer. This ordering follows the pattern of mortality risk across occupations reported by Moore and Hayward.[47]

Total household income comes from a series of questions asked in the 1984 interview about income received by all family members during the calendar year 1983. The detailed nature of the questions is likely to yield more reliable measurement of income than would be obtained from a single question. In contrast to the case for other income-based indicators described in the next paragraph, we do not subtract taxes from household income, given that the data required for such an adjustment are not likely to be available in administrative data sources. Similarly, it may not be feasible to collect sufficiently high-quality income information from death certificates.

Survey-Based Indicators

Our list of survey-based indicators consists of SES indicators that can be collected in a cross-sectional or short-run longitudinal household survey. Our household-income indicator averages reports of household income over the 5 calendar years between 1979 and 1983. We inflated all dollar-based indicators in our analysis to 1984 price levels using the CPI-UX1 component of the Consumer Price Index. To approximate disposable household income, we subtracted federal income taxes and social security taxes from the household's total cash income.

We obtained a household size–adjusted indicator of household income by dividing an individual's household income by a Census Bureau–based poverty threshold that accounts for family size. For example, in 1999, the poverty threshold for a family of 4—2 adults and 2 children—was $16 895. An individual with that level of household income would have an "income-to-needs" ratio of 1.0; an income of $33 790 would produce a ratio of 2.0. We constructed a measure of household wealth at the time of the 1984 interview from a sequence of questions designed to gather comprehensive information about the assets and liabilities of the household.

Exogenous Indicators From Long-Term Prospective Studies

That SES may reflect rather than cause health status is a persistent problem for studies of SES–health linkages. The PSID data span a long period dating back to 1968 and thus provide researchers with SES measurements from a decade or more before the period over which mortality is measured. Our strategy for compiling a set of exogenous SES indicators was to measure everything before the 1976 interview and to adjust our regression estimates to reflect whether individuals reported health limitations during that interview. Our 2 exogenous indicators were household income and family size–adjusted household income, both averaged over the years between 1967 and 1975. To minimize the possible effects of health selection in the analysis, we also controlled for disability, as defined by a 1976 self-reported response to the question, "Do you have any physical or nervous condition that limits the type of work or the amount of work that you can do?"

We related SES indicators to mortality by creating indices of inequality based on each of our socioeconomic indicators[28,48] and estimating the relationship between these indices and mortality using Poisson regression. In analyses not included here, we also used Cox regression models to estimate the relative mortality risk of individuals in the bottom vs the top deciles of the income and wealth distributions. Results were similar to those reported here.

Following Pamuk,[49] Kunst and Mackenback,[48] and Smith et al.,[28] we created indices for each of our SES indicators by assuming that the SES of a group (e.g., those who did not complete high school) is determined by the group's relative position in the hierarchy for that indicator (e.g., education). Thus, the socioeconomic position of each group is assigned a value between 0 and 1 based on the proportion of the population with a higher position on the SES indicator than the midpoint of the given group. For example, if 10% of the population were in the highest educational group, the relative position of its members would be between 0 and 0.10, the midpoint being 0.05. If the next group contained an additional 16% of the population, this group would be assigned an index value of 0.18 (=0.1 + [0.16/2]). We calculated an index of this type for each of our SES indicators.

We used Poisson (log-linear) regression to examine the relation of numerical indicators of SES to mortality. Coefficients transformed by (expβ) were used to show the relative risk of mortality for those at the bottom of the social hierarchy compared with those at the top. Following Smith et al.,[28] we referred to the relative inequality index as RII.

RESULTS

Table 2 presents Poisson regression–based risk estimates and 95% confidence intervals for our various SES indicators. We obtained the estimates in each cell in the table from regressions containing age, race/ethnicity, and the indicated SES indicator only. In cases where the male and female samples are combined, the regressions also control additively for sex.

The first three rows of Table 2 reveal that the inequality index method produces a significant mortality association for occupation and family income, but not education, in the nonelderly cohort. (Because all SES contrasts are reverse scaled, a risk estimate that exceeds 1.0 indicates higher mortality associated with lower SES levels.) Breaking the nonelderly cohort down by sex produces somewhat higher SES-related mortality risks for women than for men (the exception being occupation), but only in the case of women's 1983 pretax family income is the risk estimate statistically significant at conventional levels. Only the family income administrative data indicator had significant mortality effects among individuals in the elderly cohort.

Results for the survey-based SES indicators (all of which measure economic resources) are presented in the fourth through sixth rows of Table 2. For the nonelderly cohort, all SES indicators were significantly associated with mortality, with relative rates of mortality standing at about 3.0. In all cases, these rates

TABLE 2—Age-, Sex-, and Race/Ethnicity-Adjusted Relative Rates of Mortality According to Administrative, Survey, and Exogenous Data Indicators[a]

	Aged 45–64			Aged ≥65
	Total	Men	Women	Total
Administrative data indicators				
Education RII	1.59 (0.96, 2.64)	1.67 (0.89, 3.10)	2.04 (0.83, 5.02)	1.48 (0.95, 2.31)
Occupation RII	2.34 (1.19, 4.57)*	2.37 (1.00, 5.63)*	2.01 (0.71, 5.70)	0.73 (0.38, 1.39)
1983 pre-tax family income RII	3.46 (2.07, 5.78)*	1.64 (0.77, 3.50)	3.87 (1.89, 7.93)*	1.58 (1.17, 2.14)*
Survey data indicators				
Wealth RII	2.86 (1.50, 5.45)*	2.51 (1.15, 5.44)*	4.51 (1.84, 11.0)*	2.05 (1.48, 2.85)*
1979–1983 post-tax family income RII	2.95 (1.67, 5.20)*	1.68 (0.82, 3.44)	4.60 (2.20, 9.64)*	1.50 (1.12, 2.00)*
1979–1983 family income-to-needs RII	3.04 (1.63, 5.68)*	1.74 (0.73, 4.16)	3.68 (1.54, 8.78)*	2.06 (1.34, 3.19)*
Exogenous indicators				
1969–1975 post-tax family income RII	1.94 (0.93, 4.08)	1.26 (0.62, 2.54)	3.97 (1.61, 9.79)*	1.38 (1.04, 1.85)*
1969–1975 family income-to-needs RII	1.95 (1.01,3.75)*	1.49 (0.72,3.06)	2.31 (0.96, 5.53)	1.47 (1.06, 2.03)*

Note. Calculations are the authors' and are based on the Panel Study of Income Dynamics. CI = confidence interval.
[a]CIs are in parentheses.
*Significant at the .05 level.

were higher for women than for men. As a final generalization, the rates were universally smaller for the elderly than for the nonelderly cohort. Comparing income indicators in the administrative and survey categories reveals that the relative mortality rates are not substantially affected either by lengthening the accounting period from 1 year to 5 years or by adjusting family income for family size.

Results for the final, exogenous set of indicators were drawn a decade or more before the beginning of the interval over which mortality is assessed (final two rows of Table 2). To enhance our efforts to assess the exogenous effects of these SES components, we introduced an additive control for 1976 self-reported work limitations into all the regressions. By and large, measuring the economic indicators of SES in the late 1960s and early 1970s reproduced the patterns found for the economic indicators measured in the late 1970s and early 1980s. Household income, in this case averaged over the years between 1967 and 1975, continued to be more strongly associated with subsequent mortality for women than for men and for the nonelderly than for the elderly cohort.

Risk ratios for the elderly cohort were evident for both the more distant and the more recent SES indicators, suggesting that economic status before and during retirement is an important determinant of postretirement health. The fact that the risk ratios are never as strong for the elderly cohort as they are for the nonelderly cohort suggests that some of the health effects of SES may take the form of survival until age 65.

To assess which SES indicators retain their explanatory power in the presence of controls for other SES indicators, we undertook the series of regressions summarized in Table 3. In all cases we used the inequality index method and controlled for sex, age, and race/ethnicity. The first row shows the relative risk (1.59) associated with education for the nonelderly cohort and includes our demographic controls but no other SES indicators. By design, this estimate is identical to the one presented in the first row and column of Table 2. In contrast, the relative risk shown in the second row (.56) includes controls for occupation and for posttax family income in the years between 1979 and 1983. In neither case are these estimates significantly different from 1.0 at conventional levels. The occupation effect is also reduced in the presence of economic controls, but the associations of income and wealth with mortality are not diminished after controlling for occupation and education. A qualitatively similar result applies to the elderly cohort, although the absolute levels of the risk ratios are considerably lower than are those for the nonelderly cohort.

DISCUSSION

Our examination of "optimal" SES indicators was decidedly empirical and was based on the indicators' sensitivity to mortality risk. We find that economic indicators are considerably more sensitive than traditional ones and suggest that the former should be a standard feature of the US measurement system for monitoring links between SES and health.

Our objective here was to enumerate alternative SES indicators and to assess their associations with mortality using prospective data from a nationally representative survey. Although we found some SES–mortality gradients for education and occupation, the most powerful associations were seen for the economic indicators—wealth and family income. These associations were generally stronger for women than for men and for the nonelderly cohort than for the elderly cohort. They diminished little when they were measured 9 to 15 years before the mortality observation window or in the presence of adjustments for education and occupation.

One of our most striking findings was the high mortality risk for women with low fam-

TABLE 3—Multivariate Analysis of Age-, Sex-, and Race/Ethnicity -Adjusted Relative Rates of Mortality According to Administrative and Survey Data Indicators (95% CI)[a]

Variables Used in Regression[b]	Age, Sex, and Race/ethnicity	Education	Occupation	1979–1983 Posttax Family Income	Relative Risk Index RII (95% CI)
Age 45–64					
Education	x				1.59 (0.96, 2.64)
Education	x		x	x	0.56 (0.25, 1.23)
Occupation	x				2.34 (1.19, 4.57)*
Occupation	x	x		x	1.67 (0.61, 4.55)
Wealth	x				2.86 (1.50, 5.45)*
Wealth	x	x	x		2.75 (1.40, 5.41)*
1979–1983 posttax family income	x				2.95 (1.67, 5.20)*
1979–1983 posttax family income	x	x	x		3.58 (1.78, 7.18)*
Age ≥65					
Education	x				1.48 (0.95, 2.31)
Education	x		x	x	1.05 (0.66, 1.69)
Occupation	x				0.73 (0.38, 1.39)
Occupation	x	x		x	0.41 (0.15, 1.15)
Wealth	x				2.05 (1.48, 2.85)*
Wealth	x	x	x		1.92 (1.38, 2.66)*
1979–1983 post-tax family income	x				1.50 (1.12, 2.00)*
1979–1983 post-tax family income	x	x	x		1.27 (0.89, 1.79)

Note. Calculations are the authors' and are based on the Panel Study of Income Dynamics. CI = confidence interval.
[a]CIs are in parentheses.
[b]x indicates variables included in regression.
*Significant at the .05 level

ily incomes during their preretirement years. This finding is in stark contrast to those of other studies that have reported a weaker socioeconomic gradient in mortality for women, particularly when education and occupational class are considered,[24] and it supports the argument that those indicators may not adequately capture women's SES. For example, women receive lower income returns from education than do men, and occupational classification systems based on the characteristics of male-dominated occupations do not capture the hierarchy of women's occupations.[39] Further research is needed to elucidate the ways in which the material and symbolic dimensions of SES differentially affect the health of men and women.

Although our analysis distinguished SES–mortality associations between elderly and nonelderly cohorts and was able to measure some components of SES more than a decade before the mortality observation window, we only began to exploit the potential of a life-course-analysis perspective on links between SES and mortality. A more complete analysis would better examine the ways in which socioeconomic resources are acquired through training and lost through failing health.

Our results suggest that economic components of SES should be a standard feature of the measurement system for monitoring links between SES and health. It is feasible to gather reasonably valid information about income and wealth in surveys without compromising response rates.[50] Efforts to gather this information as part of collecting administrative data may be more difficult. However, the far superior explanatory power of income- and wealth-based indicators of SES as compared with the more conventional indicators of education and occupation suggests the value of methodological efforts to support the collection of economic indicators as part of administrative data systems. ■

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References

1. Moss N, Krieger N. Measuring social inequalities in health. *Public Health Rep.* 1995;110:302–305.

2. Adler NE, Boyce T, Chesney MA, Folkman S, Syme SL. Socioeconomic inequalities in health: no easy solution. *JAMA.* 1993;269:3140–3145.

3. Feldman JJ, Makuc DM, Kleinman JC, Cornoni-Huntley J. National trends in educational differentials in mortality. *Am J Epidemiol.* 1989;129:919–933.

4. Duleep HO. Measuring socioeconomic mortality differentials over time. *Demography.* 1989;26: 345–351.

5. 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.

6. Hahn RA, Eaker ED, Barker ND, Teutsch SM, Sosniak WA, Krieger N. Poverty and death in the United States–1973 and 1991. *Epidemiology.* 1995;6: 490–497.

7. Krieger N, Chen JT, Ebel G. Can we monitor socioeconomic inequalities in health? A survey of US Health Departments' data collection and reporting practices. *Public Health Rep.* 1997;112:481–491.

8. Williams DR. Missed opportunities in monitoring socioeconomic status. *Public Health Rep.* 1997;112: 492–494.

9. Navarro V. Race or class versus race and class: mortality differentials in the United States. *Lancet.* 1990;336:1238–1240.

10. Recommendations of the conference on Measuring Social Inequalities in Health. *Int J Health Serv.* 1996;26:521–527.

11. National Committee on Vital and Health Statistics. *Diversity and Health Care Data Base: A Preamble for Policymakers.* Washington, DC: US Dept of Health and Human Services; 1993. DHHS publication PHS 93-1205:3–19.

12. Winkleby M, Jatulis D, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *Am J Public Health.* 1992;82:816–820.

13. Kotler P, Wingard D. The effect of occupational, marital, and parental roles on mortality: the Alameda County study. *Am J Public Health.* 1989;79:607–612.

14. Lahelma E, Valkonen T. Health and social inequities in Finland and elsewhere. *Soc Sci Med.* 1990; 31:257–265.

15. Kitagawa EM, Hauser PM. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology.* Cambridge, Mass: Harvard University Press; 1973.

16. McDonough P, Duncan GJ, Williams DR, House J. Income dynamics and adult mortality in the US, 1972–1989. *Am J Public Health.* 1997;87:1476–1483.

17. Krieger N, Williams DR, Moss N. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annu Rev Public Health.* 1997;18: 341–378.

18. Williams DR, Collins C. US socioeconomic and racial differences in health. *Annual Review of Sociology.* 1995;21:349–386.

19. Liberatos P, Link B, Kelsey J. The measurement of social class in epidemiology. *Epidemiol Rev.* 1988;10: 87–121.

20. House JS, Kessler RC, Herzog AR, Mero R, Kinney A, Breslow M. Age, socioeconomic status, and health. *Milbank Q.* 1990;68:383–411.

21. House JS, Lepowski JM, Kinney AM, Mero RP, Kessler RC, Herzog AR. The social stratification of aging and health. *J Health Soc Behav.* 1994;35: 213–234.

22. Elo IT, Preston SH. Educational differences in mortality: United States 1979–1985. *Soc Sci Med.* 1996;42:47–57.

23. Link BG, Phelan J. Social conditions as fundamental causes of disease. *J Health Soc Behav.* 1995(extra issue):80–94.

24. Macintyre S, Hunt K. Socio-economic position, gender and health: how do they interact? *Journal of Health Psychology.* 1997;2:315–334.

25. Psacharoupoulos G. Returns to education: a further international update and implications. *Journal of Human Resources.* 1985;20:583–604.

26. Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? Variations in adult health behaviours and psychosocial characteristics by stages of the socioeconomic life course. *Soc Sci Med.* 1997;44: 809–819.

27. Ross C, Wu C. The links between education and health. *American Sociological Review.* 1995;60: 719–745.

28. Davey Smith G, Hart C, Hold D, et al. Education and occupational social class: which is the more important indicator of mortality risk? *J Epidemiol Community Health.* 1998;52:153–160.

29. Johnson JV, Stewart W, Hall EM, Fredlund P, Theorell T. Long-term psychosocial work environment and cardiovascular mortality among Swedish men. *Am J Public Health.* 1996;86:324–331.

30. Karasek RA, Theorell T. *Healthy Work.* New York, NY: Basic Books; 1990.

31. Volger C, Pahl J. Money, power and inequality within marriage. *The Sociological Review.* 1994;42: 263–288.

32. Pahl J. Household spending, personal spending, and the control of money in marriage. *Sociology.* 1990; 24:119–138.

33. Robert S, House JS. SES differentials in health by age and alternative indicators of SES. *J Aging Health.* 1996;8(3):359–388.

34. Mare RD. Socio-economic careers and differential mortality among older men in the United States. In: Vallin J, D'Souza S, eds. *Measurement and Analysis of Mortality—New Approaches.* Oxford, England: Clarendon Press; 1990:362–387.

35. Smith JP, Kington R. *Demographic and Economic Correlates of Health in Old Age.* Santa Monica, Calif: RAND; 1996. Laboratory Population Progress Working Paper Series, No. 96–04.

36. Filakti H, Fox J. Differences in mortality by housing tenure and by car access from the OPCS Longitudinal Study. *Popul Trends.* 1995;(81):27–30.

37. Wadsworth ME. Health inequalities in the life course perspective. *Soc Sci Med.* 1997;44:859–869.

38. Beckett M. Converging health inequalities in later life—an artifact of mortality selection. *J Health Soc Behav.* 2000;41:106–119.

39. McDonough P, Williams DR, House J, Duncan GJ. Gender and the socioeconomic gradient in mortality. *J Health Soc Behav.* 1999; 40:17–31.

40. Backlund ESPD, Johnson NJ. A comparison of the relationships of education and income with mortality: the National Longitudinal Mortality Study. *Soc Sci Med.* 1999;49:1173–1384.

41. Kaplan G, Seeman T, Cohen R, Knudsen L, Guralnik J. Mortality among the elderly in the Alameda County Study: behavioral and demographic risk factors. *Am J Public Health.* 1987;77:307–312.

42. Williams DR, Takeuchi D, Adair R. Socioeconomic status and psychiatric disorder among blacks and whites. *Social Forces.* 1992;71:179–194.

43. Kessler RC, Neighbors HW. A new perspective on the relationships among race, social class, and psychological distress. *J Health Soc Behav.* 1986;27:107–115.

44. 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 6):82–122.

45. Fitzgerald J, Gottschalk P, Moffitt R. An analysis of sample attrition in panel data: the Michigan Panel Study of Income Dynamics. *Journal of Human Resources.* 1998;23:251–299.

46. *Stata. Version 6.0* [computer program]. College Station, Tex: Stata Corp; 1999.

47. Moore DE, Hayward MD. Occupational careers and mortality of older men. *Demography.* 1990;27: 31–53.

48. Kunst AE, Mackenback JP. The size of mortality differences associated with educational level in nine industrialized countries. *Am J Public Health.* 1994;84: 932–937.

49. Pamuk ER. Social class and inequality in mortality from 1921 to 1972 in England and Wales. *Popul Stud (Camb).* 1985;39:17–31.

50. Duncan GJ, Petersen E. The long and the short of asking questions about income, wealth, and labor supply. *Soc Sci Res.* 2001;30:248–263.