Socioeconomic Status in Health Research
One Size Does Not Fit All

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Problems with measuring socioeconomic status (SES)—frequently included in clinical and public health studies as a control variable and less frequently as the variable(s) of main interest—could affect research findings and conclusions, with implications for practice and policy. We critically examine standard SES measurement approaches, illustrating problems with examples from new analyses and the literature. For example, marked racial/ethnic differences in income at a given educational level and in wealth at a given income level raise questions about the socioeconomic comparability of individuals who are similar on education or income alone. Evidence also shows that conclusions about nonsocioeconomic causes of racial/ethnic differences in health may depend on the measure—eg, income, wealth, education, occupation, neighborhood socioeconomic characteristics, or past socioeconomic experiences—used to "control for SES," suggesting that findings from studies that have measured limited aspects of SES should be reassessed. We recommend an outcome- and social group–specific approach to SES measurement that involves (1) considering plausible explanatory pathways and mechanisms, (2) measuring as much relevant socioeconomic information as possible, (3) specifying the particular socioeconomic factors measured (rather than SES overall), and (4) systematically considering how potentially important unmeasured socioeconomic factors may affect conclusions. Better SES measures are needed in data sources, but improvements could be made by using existing information more thoughtfully and acknowledging its limitations.

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THE TERMS "SOCIOECONOMIC STATUS," "socioeconomic position," and "social class" (collectively, "SES") are widely used in health research, reflecting widespread albeit often implicit recognition of the importance of socioeconomic factors for diverse health outcomes. Most health studies that consider SES treat socioeconomic characteristics as potential confounders of relationships between other variables and health. Others explicitly examine relationships between SES and health, seeking to better understand the associations that have been repeatedly observed.[1-22] The social science and social epidemiology literature consistently treats SES as a multidimensional construct comprising diverse socioeconomic factors (typically, economic resources, power, and/or prestige).[6,7,23-30] Different socioeconomic factors could affect health at different times in the life course,[31-33] operating at different levels (eg, individual, household, neighborhood)[30,34-37] and through different causal pathways[3,6,7,9,38-45] (eg, by determining exposures, vulnerability, or even direct physiological effects).[40,42,44,45] Socioeconomic factors can interact with other social characteristics, such as racial/ethnic group and sex, to produce different health effects across groups.[9,10,15,27,46-52] Despite expert consensus that SES is complex and multifactorial, most health studies that consider SES use a single socioeconomic variable measured at a single period and level. Often, very few categories are used (eg, poor/nonpoor, less than high school/high school graduation or more schooling), which could obscure important social gradients in health that apply across the entire socioeconomic spectrum.[2,8,9] Occupation is frequently used as a measure of SES in Europe,[11-14,16,17,52] while income or education is more commonly used in the United States. Regardless of the measure(s) used, most studies include SES variables without justifying why a given measure was selected over others, without explaining its meaning for a given analysis, and without discussing how

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unmeasured socioeconomic differences might have affected findings.

This article critically examines several widespread standard practices in SES measurement, discussing key concepts and providing examples to illustrate problems with those practices. The examples were chosen to illustrate SES measurement issues, not to gain new knowledge about the role of socioeconomic or other social factors in the selected health indicators. Our goals were to increase awareness—not only among health researchers but also among policy makers and practitioners who use health research findings—about inherent problems with standard methods of measuring and interpreting socioeconomic characteristics in health research, as well as to encourage improved approaches. While excellent critiques have been available,[10,25-28,53,54] the persistence of problematic approaches to SES measurement indicates that these documents have not yet influenced most researchers' practices. In many ways, this article parallels a recent *JAMA* Editorial critiquing the ways in which race/ethnicity is commonly measured in health research[55] and suggesting improved approaches based on more sound conceptualization.

Methods

To illustrate key points, we selected examples from existing literature and from new analyses of several national and statewide surveys, using the most recent data available that were suitable for the desired analyses. The new analyses were planned a priori to examine a range of (1) widely used, high-quality, population-based data sources that represent a range of data collection methods (eg, household vs telephone survey); (2) indicators of different aspects of health (status, behaviors, care) in (3) different life stages; and (4) different commonly used and reasonable measures of income and education. Data sources, samples, and key SES and health-related variables for the new analyses are summarized in TABLE 1. We used 5 nationally or statewide-representative data sources with well-documented strengths and limitations: the multistate Behavioral Risk Factor Surveillance System (BRFSS), 2004[56]; the National Health Interview Survey (NHIS) linked with the National Death Index, 1989-1994, with mortality follow-up through 1997 (mortality follow-up is not currently available for later years of the NHIS)[57]; the Third National Health and Nutrition Examination Survey (NHANES III), 1988-1994 (both income and education were measured

Table 1. Summary of Data Sources, Samples, Measures of Socioeconomic Status (SES), and Dependent Variables Used in New Analyses of Health Surveys

Data Source	Age Group, y	Racial/Ethnic Groups	Measures of SES*	Dependent Variables (Health-Related Indicators)
Behavioral Risk Factor Surveillance System, 2004[56]	18-74 (n = 255 896)	Black (non-Hispanic) Hispanic White (non-Hispanic)	Poverty level Income (categories) Educational level	Cigarette smoking Obesity Sedentary
National Health Interview Survey, 1989-1994 (mortality follow-up through 1997)[57]	18-64 (n = 380 552)	Black (non-Hispanic) Mexican American White (non-Hispanic)	Poverty level Income (continuous) Income/needs (continuous) Income (quartiles) Income/needs (quartiles) Educational level Education, y	Fair or poor health status All-cause mortality Heart disease mortality Homicide Motor vehicle fatalities
Third National Health and Nutrition Examination Survey, 1988-1994[58]	1-5 (n = 5493) <17 (n = 12 388) 25-64 (n = 10 029)	Black (non-Hispanic) Mexican American White (non-Hispanic)	Poverty level Income (continuous) Educational level	Elevated lead levels (ages 1-5 y) Asthma (ages <17 y) Cigarette smoking (ages 25-64 y) Obesity (ages 25-64 y) Hypertension (ages 25-64 y) Diabetes (ages 25-64 y)
National Longitudinal Study of Adolescent Health, 1994-1995[59]	11-21 (n = 14 282)	Black (non-Hispanic) Cuban Mexican American Puerto Rican White (non-Hispanic)	Poverty level Income (continuous) Income/needs (continuous) Income (quartiles) Income/needs (quartiles) Educational level	Cigarette smoking Initiation of sexual intercourse Violent behavior Binge drinking Marijuana use
California Maternal and Infant Health Assessment, 1999-2004[60]	>24 (n = 13 952)	Asian/Pacific Islander (immigrant or US-born) Black Latina (immigrant or US-born) White	Poverty level Income (continuous) Income/needs (continuous) Income (quartiles) Income/needs (quartiles) Educational level Education, y	Unintended pregnancy Delayed or no prenatal care Low birth weight Never breastfed

*Poverty level indicates annual income estimated in categories defined by 100% increments of the federal poverty level according to family or household size (0%-100%, 101%-200%, 201%-300%, 301%-400%, >400%, unknown).

Income (categories) indicates annual income in categories corresponding to ranges in dollars; income (continuous), annual income in continuous dollars estimated as the midpoints of a given income range; income/needs (continuous), annual income in continuous dollars divided by family size; income (quartiles), annual income in continuous dollars grouped into empirical quartiles; and income/needs (quartiles), annual income in continuous dollars divided by family size, grouped into empirical quartiles.

Educational level indicates completed education in levels according to earned credentials (<9 years, some high school, high school graduate/General Equivalency Diploma, some college, college graduate or more); for California Maternal and Infant Health Assessment, <9 years and some high school are combined; the National Longitudinal Study of Adolescent Health also includes a category for unknown education. Education, y indicates completed education in years.

Table 2. Mean Family Income by Educational Level and Racial/Ethnic Group Among Adults Aged 18-64 Years—National Health Interview Survey, 1989-1994 (n = 380 552)

Educational Level, y	Mean Income (95% Confidence Interval), $			
	Black	Mexican American	White	Overall
<9	15 503 (14 851-16 154)	19 104 (17 549-20 659)	22 707 (21 935-23 479)	20 551 (19 868-21 234)
9-11	17 743 (17 051-18 434)	22 377 (20 807-23 948)	28 573 (28 062-29 083)	25 945 (25 486-26 403)
12	25 337 (24 529-26 144)	30 945 (29 791-32 098)	37 853 (37 400-38 305)	36 022 (35 613-36 432)
13-15	33 026 (31 898-34 154)	37 642 (36 089-39 195)	43 197 (42 510-43 884)	41 857 (41 228-42 487)
≥16	46 815 (45 535-48 095)	48 055 (46 137-49 973)	55 277 (54 725-55 829)	54 606 (54 064-55 149)
Overall	27 937 (27 123-28 752)	27 927 (26 498-29 356)	42 113 (41 626-42 600)	39 716 (39 274-40 159)

more adequately in NHANES III than in the most recent NHANES data)[58]; the National Longitudinal Study of Adolescent Health (Add Health), 1994-1995 (the baseline survey, when parents or guardians of the adolescents responded to questions on income and education)[59]; and the Maternal and Infant Health Assessment (MIHA), 1999-2004,[60] a statewide survey of postpartum women in California supported by the California Department of Health Services Maternal, Child and Adolescent Health Branch.[61-64] Using SAS software,[65] we examined correlations among multiple individual- or household-level measures of current education and income. To provide additional illustrative examples, we used SUDAAN software[66] and the specified data sources and samples to construct a series of weighted unadjusted and multivariate logistic regression models for each of 23 health-related indicators (listed as dependent variables in Table 1, counting obesity and smoking as separate indicators in different data sources or samples). These models examined how observed associations—expressed as odds ratios with 95% confidence intervals—between racial/ethnic groups and the health-related indicators varied by the income and/or education measures (see Table 1 footnotes) used as covariables to reflect SES; models also included age and sex (or parity, in MIHA), as well as family structure (in Add Health). Reference groups were those with the highest income or educational attainment. Log likelihood ratio tests were used to assess goodness of fit.[67] Further details about methods are included in a technical appendix available from the authors on request or at http://www.ucsf.edu/csdh.

Race/ethnicity, regarded as a social construct, was assessed in the study primarily to examine whether observed associations between racial/ethnic groups and health-related indicators varied by the income measures, education measures, or both used as covariables to reflect SES; we also examined how a range of socioeconomic factors varied by racial/ethnic group. While racial/ethnic groups were categorized differently depending on the data source (see Table 1 or text below), all categories were based on self-reported information about respondents' primary racial/ethnic identification. The MIHA included Latino/Hispanic as a separate racial/ethnic category; the BRFSS, NHIS, NHANES III, and Add Health surveys included separate questions about race and Hispanic ethnicity, which we used to create mutually exclusive racial/ethnic groups.

Critique of SES Measurement Approaches in Health Research

Education and Income: Not Interchangeable. Socioeconomic status is often implicitly or explicitly equated with income, especially in the United States. Despite wide recognition of its importance for health, income information is considered to be sensitive and is not measured in many studies. Information about education (typically measured as years completed or credentials of formal schooling) is more easily obtained and is frequently treated as a proxy for income (or for SES overall). When both education and income are available, researchers may hesitate to include both in analytic models because of concerns about colinearity. Evidence from the literature and our new analyses indicates, however, that while standard measures of education and income are correlated, these correlations are generally not strong enough to justify using education as a proxy for income (or vice versa). Earnings can vary at similar educational levels, particularly across different social (eg, racial/ethnic, sex, age) groups.

For example, TABLE 2 shows, based on NHIS data, that black and Mexican American adults at every educational level had significantly lower mean incomes compared with white adults of similar educational attainment (eg, 33% and 18% lower for those with 12 years of schooling). This difference may reflect not only unequal employment opportunities and rewards but variations in educational quality.[10] While measuring credentials is generally preferred to years of schooling for the purposes of reflecting SES,[27,28,68,69] neither captures potentially dramatic differences across schools in prestige or resources, which may contribute to differences in future earnings. TABLE 3 displays correlations between education and income (see Table 3 footnotes) overall and within racial/ethnic groups for each data source or sample. Consistent with other studies,[25,51,70,71] income-education correlations—most less than 0.50—were not strong enough to justify using income and education as proxies for each other.

Table 3. Spearman Correlation Coefficients Between Poverty Level and Educational Level Overall and by Racial/Ethnic Group, by Data Source and Age Group*

	Data Source/Age Group						
			NHANES III, 1988-1994				
Race/Ethnicity	BRFSS, 2004, 18-74 y	NHIS, 1989-1994, 18-64 y†	1-5 y	<17 y	25-64 y	Add Health, 1994-1995, 11-21 y	MIHA, 1999-2004, >24y
Black	0.45	0.42	0.44	0.42	0.42	0.45	0.59
Hispanic	0.50						
Mexican American		0.44	0.46	0.52	0.50	0.40	
Cuban						0.42	
Puerto Rican						0.37	
Asian/Pacific Islander							
Immigrant							0.48
US-born							0.47
Latina							
Immigrant							0.35
US-born							0.56
White	0.41	0.37	0.54	0.50	0.40	0.44	0.49
Overall	0.48	0.41	0.58	0.55	0.44	0.48	0.67

Abbreviations: Add Health, National Longitudinal Study of Adolescent Health; BRFSS, Behavioral Risk Factor Surveillance System; MIHA, California Maternal and Infant Health Assessment; NHANES III, Third National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey.
*Poverty level indicates annual income estimated in categories defined by 100% increments of the federal poverty level according to family or household size (0%-100%, 101%-200%, 201%-300%, 301%-400%, >400%, unknown); educational level indicates completed education in levels according to earned credentials (<9 years, some high school, high school graduate/General Equivalency Diploma, some college, college graduate or more); for MIHA <9 years and some high school are combined; Add Health also includes a category for unknown education.
†With mortality follow-up through 1997.

Table 4. Odds Ratios for Racial/Ethnic Disparities in Fair or Poor Health Among Adults Aged 18-64 Years—National Health Interview Survey, 1989-1994 (n = 380 552)

	OR (95% CI)†	
SES Measure in Model*	Black Non-Hispanic	Mexican American
None (baseline)	2.47 (2.30-2.64)	2.16 (2.01-2.32)
Poverty level‡	1.65 (1.56-1.76)	1.30 (1.22-1.39)
Income, per $1000§	1.67 (1.57-1.78)	1.44 (1.32-1.56)
Educational level‖	1.96 (1.85-2.08)	1.06 (0.99-1.14)
Education, per 1 y	2.02 (1.91-2.14)	0.89 (0.82-0.97)
Poverty level and educational level	1.53 (1.45-1.61)	0.86 (0.81-0.93)

Abbreviations: CI, confidence interval; OR, odds ratio; SES, socioeconomic status.
*All models included race/ethnicity, age, and sex.
†White non-Hispanic is the reference group.
‡Annual income estimated in categories defined by 100% increments of the federal poverty level according to family or household size (0%-100%, 101%-200%, 201%-300%, 301%-400%, >400%, unknown).
§Annual income in continuous dollars estimated as the midpoints of a given income range.
‖Completed education in levels according to earned credentials (<9 years, some high school, high school graduate/General Equivalency Diploma, some college, college graduate or more).

To further illustrate practical implications of treating education as an income proxy, we examined how conclusions regarding racial/ethnic disparities in health might vary depending on whether income or education was used to measure SES. TABLE 4 displays results on racial/ethnic differences in self-rated health among adults aged 18 to 64 years from 6 multivariate models using NHIS data. The models differed by whether and how income and education were included as covariables (see Table 4 footnotes); all models included race/ethnicity, age, and sex. When income (measured continuously or grouped by poverty level) was used to "adjust for SES," Mexican Americans appeared to be at significantly increased risk of fair or poor health compared with non-Hispanic whites; however, risks appeared similar when educational level alone was included and significantly lower when either years of education or both poverty and educational levels were included. Comparing blacks and whites, higher risks were seen for blacks regardless of the income or education measure used; however, the relevant odds ratios were significantly smaller after adjustment for income or poverty level. Similarly, TABLE 5 reveals disparities in receipt of delayed (after the first trimester) or no prenatal care among women who gave birth in California during 1999-2004; all models used MIHA data and included race/ethnicity, age, and parity. In separate comparisons of black and immigrant Latina women with white women, significant disparities in delayed or no prenatal care were seen when adjusting for either education measure alone but not when adjusting for either income measure alone or together with education. Although differences often were not statistically significant, one would have reached different conclusions about the significance, magnitude, or direction of racial/ethnic disparities in 10 of the 23 health indicators we examined, depending on whether (or less frequently, how) income and education were measured. For 20 of the 23 health indicators, model fit was significantly better

when both income and education were included, indicating that both factors should be considered (data available from authors on request or at http://www.ucsf.edu/csdh).

Both income and education can influence the etiology of many health outcomes, in part through pathways involving material resources. Education also can reflect a range of noneconomic social characteristics (eg, general and health-related knowledge, literacy, and problem-solving skills; prestige; influence over others and one's own life)[68,72-76] with important health effects; thus, for many health outcomes, education should be considered in addition to—not instead of—income, accumulated wealth, and other more directly economic factors.

Income: Not a Proxy for Wealth. Important links between economic resources and health, operating through diverse causal pathways, are widely recognized. While income is the most commonly used measure of economic resources in affluent countries, total accumulated economic resources or "wealth" could be at least as important for health; for example, wealth can buffer the effects of temporarily low income due to unemployment or illness and can reflect power or influence over others.[77] Furthermore, wealth can vary dramatically across different social groups with similar incomes. For example, TABLE 6, based on 2000 data from the Census Bureau, shows that, in the lowest income quintile, households headed by whites had on average more than 400 times as much wealth as those headed by blacks, and that, in higher income quintiles, whites had approximately 3 to 9 times the wealth of blacks; these differences were statistically significant (see Table 6 footnotes).[78]

With notable exceptions,[7,18,25,29,46,79-84] few health studies in affluent countries have measured wealth. Like income, wealth can be a sensitive topic, and standard methods of calculating net worth can be laborious. Some studies have observed wealth effects on health using simpler measures such as home[7,29,46,80] or car[46,84] ownership or a single question on "liquid assets,"[83] even after controlling for income, another socioeconomic measure, or both.[7,29,46,83,84] In summary, there are strong conceptual and empirical grounds for measuring wealth in health studies and for concluding that income is not an adequate measure of wealth.

Inadequacy of Standard US Occupational Categories. Occupational categories based on prestige, skills, social influence, and/or power have been the primary basis for socioeconomic classification in western European countries. Studies have repeatedly found strong relationships between occupational status using such classifications (eg, manual vs nonmanual labor, or graded hierarchies according to prestige or skills) and diverse health indicators,[2,8,12,15-17,46,84-90] even after controlling for car ownership[84] or income and education.[48] Stepwise gradients in mortality and cardiovascular outcomes have been observed in the British civil service hierarchy, with individuals in each occupational grade experiencing worse outcomes than those in the grade immediately above,[52] even after adjusting for health-related behaviors[2,17]; no group was poor, and financial access to medical care was unlikely to account for the differences. One explanation is variation in the psychosocial characteristics of one's occupation,[17] including control over one's work.[17,91-93]

Health studies in the United States rarely measure occupation, however. Occupational information is included in vital statistics and some national health surveys, but these data were not intended—and do not appear to be meaningful—as SES measures, because the categories include workers with diverse prestige, skills, power, and/or earnings. For example, the 2000 Standard Occupational Classification System[94] classifies chief executive officers, town clerks, and tenant farmers under "Man-

Table 5. Odds Ratios for Racial/Ethnic Disparities in Delayed or No Prenatal Care Among Childbearing Women Aged 25 Years and Older—California Maternal and Infant Health Assessment, 1999-2004 (n = 13 952)

	OR (95% CI)†	
SES Measure in Model*	Black	Latina Immigrant
None (baseline)	1.86 (1.53-2.26)	2.21 (1.90-2.57)
Poverty level‡	1.16 (0.95-1.43)	1.08 (0.91-1.28)
Income, per $1000‡	1.12 (0.91-1.40)	1.05 (0.88-1.26)
Educational level§	1.57 (1.29-1.92)	1.47 (1.22-1.76)
Education, per 1 y	1.72 (1.41-2.10)	1.37 (1.12-1.67)
Poverty level and educational level	1.13 (0.91-1.39)	0.98 (0.82-1.18)

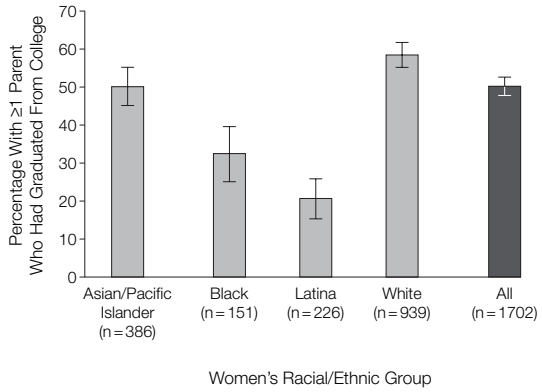
Abbreviations: CI, confidence interval; OR, odds ratio; SES, socioeconomic status.
*All models included race/ethnicity, age, and parity.
†White is the reference group.
‡See Table 4 footnotes for definition.
§Completed education in levels according to earned credentials (<9 years/some high school, high school graduate/General Equivalency Diploma, some college, college graduate or more).

Table 6. Median Net Worth in Dollars (Excluding Home Equity) by Quintile of Monthly Household Income and Householder's Racial/Ethnic Group, 2000*

Quintile	Black†	Hispanic‡	White Non-Hispanic
Lowest	57	500	24 000
Second	5275	5670	48 500
Third	11 500	11 200	59 500
Fourth	32 600	36 225	92 842
Highest	65 141	73 032	208 023

*From US Census Bureau Survey of Income and Program Participation.[78] Standard errors are not reported by the source; however, both the comparisons of blacks with whites and of Hispanics with whites are stated to be significantly different.
†Report does not indicate whether blacks are Non-Hispanic.
‡Persons of Hispanic origin may be of any race.

Figure 1. Percentage of College-Graduate Childbearing Women Aged 25 Years and Older With ≥1 College-Graduate Parent—California Maternal and Infant Health Assessment, 2003-2004 (n=1702)



Error bars indicate 95% confidence intervals.

agement" and head chefs, waitresses, and dishwashers under "Food Preparation and Serving Related." Several authors[25-28,53] have provided detailed critiques of occupational classifications. Some researchers have grouped the standard occupational classifications into manual and nonmanual work categories and found strong associations with health outcomes.[48] While this may be worthwhile when better alternatives are unavailable, more meaningful occupational classifications (eg, such as questions from Karasek[92,93] measuring control and demands at work) are needed to capture information about important differences in occupation-related prestige or power that could affect health. Occupational measures, however, present challenges for classifying persons outside the paid labor force (thus disproportionately affecting women) or the chronically unemployed.

Importance of Past Socioeconomic Experiences. Childhood SES may influence adult health independently of adult SES.[6,13,31-33,79,95-99] Acknowledging that the relative importance of SES early in life varies with health outcomes, Smith and Ben-Shlomo[13] concluded that "studies with data on socioeconomic circumstances at only one stage of life are inadequate for fully elucidating the contribution of socioeconomic factors to health and mortality risk." Past socioeconomic factors could act independently or modify the effects of current factors on health.[13,39,100] Changes in SES over time, including dramatic loss of income, can affect later health,[90,101,102] and poverty can have cumulative health effects.[99,103,104] Different socioeconomic factors could be more or less important at different stages of life.[83]

Standard practice for measuring SES in most health studies, however, is to include only measures of current or recent socioeconomic characteristics; apart from some occupational health studies, socioeconomic experiences during earlier life stages are rarely measured. Socioeconomic status in childhood generally is related to SES in adulthood,[105-107] but important SES characteristics earlier in life (eg, parents' educational attainment) may not be reflected in measures of current SES, particularly for some population groups. For example, when their own parents' education was examined among women older than 24 years who gave birth in California during 2003-2004, only 50% of college-graduate women overall had been raised by a college-graduate parent. In addition, this percentage varied significantly across racial/ethnic groups (for all comparisons except between blacks and Latinas); as shown in FIGURE 1, 50% of Asian/Pacific Islander, 34% of black, 20% of Latina, and 58% of white college-graduate women had been raised by a college-graduate parent. Lack of correspondence between educational attainment of women and their parents was seen for women at all educational levels (data available on request or at http://www.ucsf.edu/csdh). Given the potentially important role that past socioeconomic experiences may play in health outcomes, practical measures of socioeconomic experiences earlier in life—eg, the highest educational attainment of either parent/guardian when an adult respondent was a child[79,108]—should be developed and tested in diverse populations.

Importance of Neighborhood Socioeconomic Conditions. Accumulating evidence suggests that an individual's health can be influenced by the socioeconomic characteristics of the neighborhood in which she or he lives, above and beyond her or his own individual-level SES.[34-37] Socioeconomic characteristics of neighborhoods could affect health through features of the physical ("built"), social, or service environments[109-113] via multiple pathways.[114] People with similar individual- or household-level socioeconomic characteristics can live in very different local environments. For example, as seen in FIGURE 2, Add Health data show that poor black and Puerto Rican adolescents (in families with incomes at or below the poverty line) lived in neighborhoods with higher poverty concentrations than their poor white counterparts; mean differences were statistically significant and similar patterns of racial/ethnic differences in neighborhood conditions were apparent among higher-income adolescents (data available on request or at http://www.ucsf.edu/csdh) and among nationally representative samples of adults[115] and women of reproductive age.[116]

Despite increasing recognition that both individual- and neighborhood-level SES can influence health, few health studies measure neighborhood features along with—rather than as proxies for—individual-level SES measures. In practice, however, many re-

searchers could consider characteristics of both individuals and their neighborhoods, despite theoretical and methodological challenges.[117-119] By linking residential addresses with census geographic codes such as census tracts, census variables (eg, percentages of poor households or of unemployed adults) can be used to describe neighborhoods; similarly, geographic coordinates (longitude/latitude) can be linked with various data sources to describe physical environments in ways that are relevant for health research.

Conclusions and Recommendations

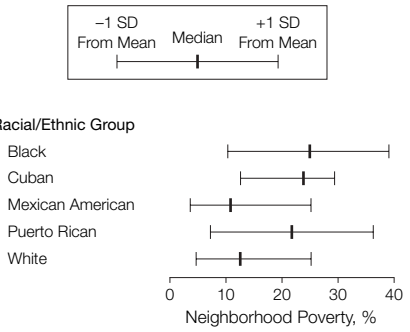
Based on the empirical evidence from new analyses and from the literature, we have reached 5 general conclusions, with corresponding recommendations for improving the measurement and interpretation of SES in health studies.

Different socioeconomic measures cannot be assumed to be interchangeable. The generally modest correlations between income and education indicate that measures of these 2 socioeconomic factors are not interchangeable; this is further supported by the examples showing that associations between racial/ethnic groups and health indicators can depend on which socioeconomic measures are used as covariables. Evidence of racial/ethnic differences in income at a given level of education, in wealth at a given level of income, in past SES at a given level of current SES, and in neighborhood SES at a given level of individual SES also supports the noninterchangeability of these variables across diverse populations. Multiple socioeconomic measures often can be included simultaneously in multivariable models without colinearity problems[20-22,61-64,70,71]; stratified analyses also should be considered. Composite SES measures, or "indices," also have been used to reflect multiple socioeconomic factors. However, few of the individual- or household-level (distinguished from community-level) indices have been validated. Most involve multiple questionable assumptions and, to an even greater extent than simpler measures, may not apply over time and across populations.[26,28] Furthermore, such composite measures, while potentially useful for classification in some studies, do not permit study of how particular SES factors influence health. Health researchers should justify the particular socioeconomic measures they have studied, avoiding claims to have measured SES overall.

Standard measures may not reflect important and relevant aspects of SES. Even studies that include multiple standard SES measures cannot examine all potentially important socioeconomic influences on health. Years of schooling received or earned credentials may not capture significant differences in educational quality that may also be relevant. Conventional US occupational groupings were not designed and are unlikely to adequately measure job-related socioeconomic characteristics that may affect health. Subjective SES[120] and experiences of economic hardship[121] could plausibly influence health through psychophysiological pathways discussed earlier but are not explicitly reflected in standard SES measures. Rather than claiming to have "controlled for SES," researchers should acknowledge the potentially relevant aspects of SES that could not be measured and explicitly consider the implications of unmeasured socioeconomic influences when interpreting findings.[70]

Racial/ethnic differences are likely to reflect unmeasured socioeconomic differences. The concerns expressed above underscore the fact that—without measuring all relevant SES dimensions, life stages, and aggregation levels (eg, individual, household, neighborhood, city)—an observed racial/ethnic disparity in health cannot be considered "independent of SES."[122] However, racial/ethnic differences also cannot be assumed to be reducible to socioeconomic issues; for example, systematic socioeconomic differences between racial/ethnic groups can reflect racial discrimination at the institutional/structural level, personal experience, or both.[10,54,123,124] Researchers who observe racial/ethnic disparities in health outcomes should explicitly acknowledge the plausible role of unmeasured aspects of SES and other potentially relevant explanations,[55] including institutional or personal experiences of discrimination. We believe that conclusions from prior research about the nature of racial/ethnic (and other social) differences in health should be thoughtfully reassessed in light of findings and recommendations in this article as well as prior literature.*

Figure 2. Distribution of Neighborhood Poverty Among Poor Adolescents by Racial/Ethnic Group—National Longitudinal Study of Adolescent Health, 1994-1995



Neighborhood poverty defined as percentage of families in the census tract who had 1989 income that was below the federal poverty level; poor adolescents defined as those aged 11-21 years and living in families with 1994 income that was at or below the federal poverty level.

A given SES measure may have different meanings in different social groups. Although our examples focused on racial/ethnic differences, similar issues may apply to other social groups categorized, for example, by age,[83] sex,[50,52,127] or urban/rural location.[128] Whenever possible, researchers should examine how findings using a given SES measure vary across social groups.

Measures of SES should be selected and interpreted thoughtfully in the context of plausible explanatory pathways through which socioeconomic factors may influence health. Researchers should select socioeconomic factors systematically, considering whether eco-

*References 10, 27, 54, 55, 70, 114, 122, 123, 125, 126.

nomic resources, education, occupation, socioeconomic factors earlier in life, and neighborhood socioeconomic conditions at any life stage could plausibly be relevant to the particular health outcome and population of interest. They should assess the feasibility of adequately measuring each potentially relevant factor using available data; when a relevant factor cannot be measured, the implications of its exclusion should be considered thoughtfully and acknowledged. If a theoretically plausible argument or evidence from previous studies indicates that a particular socioeconomic factor is unlikely to be relevant for the given outcome or population of interest, it may not be necessary to include that factor. However, the approach we recommend would shift the burden to the researcher to justify why a study does not include measures of economic resources, education, occupation, past SES, and neighborhood socioeconomic conditions and to discuss fully the implications of unmeasured factors when stating conclusions.

Final Comments

We have presented conceptual arguments and empirical examples from diverse data sources, populations, and health-related indicators to illustrate several major and pervasive problems with the standard ways in which SES is measured in health research. The examples presented here highlight the potential consequences of inadequately measuring socioeconomic factors, particularly in studies of racial/ethnic disparities; similar caveats apply to studies of other social disparities, eg, by age, sex, or geographic residence. Our aim has been to provide convincing evidence for a wide audience of health researchers and users of health research findings. While previous authors have written about many of these issues, the messages apparently have not reached most clinical and public health researchers and policy makers. In particular, the evidence presented here, reinforced by the discussion in a recent *JAMA* Editorial on measuring racial/ethnic group,[55] calls for a careful reassessment of conclusions about the etiologic basis of racial/ethnic differences in health based on studies with limited socioeconomic information.

These findings highlight the challenges in capturing the multidimensional nature of SES and the limitations of standard measures. Should we despair of measuring SES adequately? We think not. Better measures are needed, along with work to develop and validate measures and measurement approaches that are as comparable across studies and populations as possible. However, health research could be improved significantly with a more conceptually and empirically sound approach to measurement of SES. Building on our own and others' work, we call for a fundamentally different conceptual approach to measuring SES in health studies. This approach is outcome- and social group–specific and rests on considering explanatory pathways and mechanisms, measuring as much relevant socioeconomic information as possible, claiming to measure only what was measured, and systematically considering how important unmeasured socioeconomic factors may affect conclusions.

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