# Age, Socioeconomic Status, and Health

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HUMAN LIFE EXPECTANCY HAS INCREASED MORE IN the past century than in all prior human history, yet the maximal human life span has not increased commensurately, if at all (Fries 1980; Preston 1977). This suggests both utopian and distopian scenarios for the future. The utopian scenario, articulated by Fries (1980), has two premises. First, the human life span is not only finite, but also relatively fixed (at about 85 years on average). Second, we will increasingly postpone the onset of morbidity and disability, thus "compressing" their duration into the last years of the life span and improving the quality of life while reducing the need for medical care. Evidence that the human life span may not be fixed, and that life expectancy may be increasing as fast or faster than the rate of postponement of the onset of morbidity and mortality, has suggested to others a more distopian scenario: gains in life expectancy merely add years to life during which people are chronically ill or disabled, and thus higher consumers of health care (Gruenberg 1977; Manton 1982; Schneider and Brody 1983; Verbrugge 1984).

Despite continuing disagreement as to whether "compression of morbidity" is now, or ever will be, a reality, proponents of both the

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utopian and distopian scenarios agree that *the* fundamental agenda for research on aging and health is to understand whether and how morbidity and functional limitations or disability can be postponed into a briefer final phase of the finite, though perhaps not fixed, human life span (*Gerontologica Perspecta* 1987). This requires moving beyond disputes over whether or not postponement or compression of morbidity is occurring in the total population. Rather we need to determine whether some *subgroups* of the population are experiencing substantially greater postponement of morbidity and functional limitations than others, and, if so, what are the implications of this for efforts to make such postponement more characteristic of the total population.

Extant theory and data in social epidemiology suggest the hypothesis that the higher socioeconomic strata in our society may now be approximating the utopian scenario of Fries and others, with levels of morbidity and functional limitations remaining low until quite late in life, whereas, in the lower socioeconomic strata, levels of morbidity and functional limitations increase steadily throughout middle and early-old age. If this hypothesis is correct, the higher socioeconomic strata can provide evidence that substantial postponement of morbidity and functional limitations is possible, and can suggest how such postponement might be achieved more generally in our population. The lower socioeconomic strata would then constitute the major challenge and target for efforts to further postpone morbidity and functional limitations.

Socioeconomic differentials in the relation of aging and health have been surprisingly neglected, not only in the disputes over compression of morbidity, but also in more general discussions of the problems of aging and health in our society (e.g., Brody, Brock, and Williams 1987; National Center for Health Statistics 1987; Shanas and Maddox 1985). Even as average life expectancy has advanced, socioeconomic differences in mortality and health have persisted, and in some cases increased, in the United States and other developed and developing countries (Kitigawa and Hauser 1973; Syme and Berkman 1976; Fingerhut, Wilson, and Feldheim 1980; Marmot, Kogevinas, and Elston 1987; Williams 1990). Their relevance for the study of aging and health has been obscured, however, by a failure to understand how such socioeconomic differences vary by age, or conversely how the relation of age to health varies by socioeconomic status (SES).

Scattered evidence suggests that socioeconomic differences in mortality, and perhaps morbidity and functional limitations as well, are greatest in the middle years of life. However, neither the nature nor reasons for this potential interaction between age and socioeconomic status is well understood. Socioeconomic differences in adult mortality have been observed to be greater in middle age (Antonovsky 1967; Goldsmith and Hirschberg 1976; Kitigawa and Hauser 1973) and relatively small in older age (Haan, Kaplan, and Camacho 1987; Kaplan et al. 1987). Yet, as Berkman (1988) notes, others report persisting socioeconomic differences in mortality until quite late in life (Fox, Goldblatt, and Jones 1985).

Data on variation by age in socioeconomic differences in morbidity and functional limitations are even more fragmentary. Satariano (1986) found somewhat larger differences by education and income on a combined measure of health, morbidity, and disability among middle-aged (40–59) versus younger (20–39) and older (60+) persons; and socioeconomic differences in functional limitations have been reported to be greatest in middle age, almost without comment, much less explanation (Newacheck et al. 1980).

Growing understanding of the role of psychosocial factors in the etiology of health and illness can now provide a theoretical rationale for why socioeconomic differences in morbidity and functional limitations should be greater in middle and early old age, or, in other terms, why higher socioeconomic groups should experience substantially greater postponement (sometimes termed "rectangularization") of morbidity and functional limitations than the lower socioeconomic strata. The etiology and course of morbidity and functional limitations in adulthood are increasingly a function of psychosocial and environmental risk factors (Rowe and Kahn 1987). These include health behaviors such as smoking, drinking, eating, and exercise (Berkman and Breslow 1983); acute and chronic psychosocial stress (Theorell 1982; Thoits 1983; House 1987a; Pearlin et al. 1981); sense of self-efficacy and control (Rodin 1986); social relationships and supports (House, Landis, and Umberson 1988); and physical, chemical, and biological, as well as psychosocial, hazards and stressors at work (Goldsmith and Hirschberg 1976; Karasek and Theorell 1990).

Existing evidence, although fragmentary, suggests that lower socioeconomic groups are disadvantaged on *all* of these risk factors. Over

the past half-century, lower socioeconomic groups have increasingly adopted (and higher SES groups have increasingly discarded) lifestyles and behaviors (cigarette smoking, high-fat diets, heavy alcoholic drinking, and sedentary lives) that have been identified over the past few decades as major risk factors for morbidity, disability, and mortality (Berkman and Breslow 1983; Williams 1990). Lower socioeconomic groups are more likely to be exposed to physical, chemical, biological, and even psychosocial hazards or stresses at work (Goldsmith and Hirschberg 1976; Karasek and Theorell 1990). They also experience greater amounts of chronic and acute stress in most areas of life (Dohrenwend and Dohrenwend 1970; Kessler 1979). Finally, the lower socioeconomic strata appear to be disadvantaged even in the quantity and quality of social relationships (House 1987b) and sense of self-efficacy and control (Mirowsky and Ross 1986). In many cases, the disadvantage of lower socioeconomic groups may be greater in middle age than in older age (e.g., because older people are more likely to have left the work force, stopped smoking, reduced alcoholic drinking) or young adulthood (e.g., when exercise levels are generally higher and the incidence of death of friends and relatives is generally low).

Further, the *impact* of these psychosocial risk factors on health should be greater in middle and early old age (e.g., 35–65) as exposure to the risk factors lengthens and biological vulnerability increases (House and Robbins 1983). Government guarantees of income maintenance and health care available to citizens aged 65+ may cushion the impact of these and other health hazards in later old age. Thus, socioeconomic differentials in morbidity and functional limitations should increase during middle and early-old age, and then converge in later old age.

## *Research Questions*

This article seeks to determine whether the postponement of morbidity and functional limitations into the last years of life is more characteristic of advantaged socioeconomic groups. We ask first how large are socioeconomic differences in health, both absolutely and relative to differentials by age, race, and sex. Second, and more important, we test whether the socioeconomic differences vary by age, or, in other words, whether the relation between age and health is constant or variable across socioeconomic groups. Having established the nature and

extent of socioeconomic differences in the relation of age to health, we then discuss the meaning and explanation of these differences. Empirical tests of these explanations are beyond the scope of this article, but will be reported in the future.

We are ultimately interested in how health changes as individuals and populations age. We are limited at this time, however, to studying cross-sectional variation in the *prevalence* of morbidity and functional limitations across age groups or cohorts. Longitudinal data are necessary to validate that our cross-sectional differences in age and health reflect patterns of *aging* and health. Such data are also essential to determine the extent to which the onset of morbidity and functional limitations is actually postponed, and the extent to which their duration is actually compressed into a briefer final period of the life span. However, national longitudinal data sets that derive from probability samples and are adequate to these tasks are just being created. We suggest directions for further research on such data sets, as well as on existing sets of cross-sectional surveys that have replicated measures of morbidity and disability over time (e.g., the National Health Interview Surveys).

## Methods

### *Samples*

The principal data are from the Americans' Changing Lives (ACL) survey, carried out by the Survey Research Center of the University of Michigan on a multistage, stratified area probability sample of noninstitutionalized persons 25 years of age or older, living in the 48 contiguous states. Blacks and persons aged 60 or over were sampled at twice the rate of nonblacks and persons under age 60, respectively. A total of 3,617 respondents were interviewed in their homes by interviewers of the Survey Research Center. These face-to-face interviews were conducted between May and October of 1986 and lasted 86 minutes on average. The response rate for all eligible individuals was 67 percent. When persons who spoke only a language other than English or Spanish or who were too ill or incompetent to be interviewed are excluded, the response rate was 70 percent. Nonresponse did not vary substantially by age, race, or other known respondent characteristics. Further, the data are weighted in all analyses to adjust for variations in proba-

bilities of selection and in response rates across sample areas. Finally, poststratification weights were added to make the weighted sample correspond to the July 1985 Bureau of Census population estimates by sex, age (25–64 vs. 65+), and region (Northeast, Midwest, South, and West). Small amounts of missing data on various items were imputed so that all cases have complete data on all variables analyzed here.

To replicate a novel set of results and ensure that they are not a function of unique characteristics of the ACL survey (e.g., data-collection organization, sample size, patterns of nonresponse), parallel analyses were conducted with the 1985 National Health Interview Survey (NHIS). This survey was carried out by the U.S. Census Bureau for the National Center for Health Statistics (National Center for Health Statistics 1986) on a multistage, stratified, area probability sample of the civilian noninstitutionalized population of the United States, with oversampling of blacks. Whereas the NHIS sample includes people of all ages ($N = 91,531$), our analyses include only people 25 years of age or older ($N = 55,690$). Again, data are weighted in all analyses to adjust for variations in selection probabilities and response rates. Our analyses rely solely on the individual-level data in the NHIS 1985 "Person File."

## *Analyses*

Results in tables 1 to 3 derive from analysis using ordinary least-squares regression. Figures 1 to 5 graph weighted category means for each subgroup shown in the figures. Standard errors, and hence significance levels, have been adjusted to take accout of the clustering, stratification, and differential selection probabilities in the ACL survey sample. For computing standard errors of means, we used the PSALMS program in OSIRIS IV based on a Taylor Series approximation. For computing standard errors of regression coefficients, we used the balanced repeated replication program (REPERR) of OSIRIS IV.

## *ACL Measures*

The ACL analyses utilized three self-report indicators of physical health: (1) the number of major *chronic conditions* experienced in the last year (out of a list of 10 such conditions: arthritis/rheumatism, lung disease, hypertension, heart attack or heart trouble, diabetes, can-

cer/malignant tumor, foot problems, stroke, fractures or broken bones, and urinary incontinence); (2) an index of *functional status* with the lowest score of 1 indicating confinement to a bed or chair and the highest score of 4 indicating ability to do heavy work around the house without difficulty; and (3) a single-item self-rating of the extent of health-related *limitation of daily activities* where the lowest value of 1 indicates that a person's daily activities are limited "a great deal" by health or health-related problems and the highest value of 5 indicates that the person's daily activities are "not at all" limited by health-related problems. We have analyzed chronic conditions not only as a total number (out of 10), but also as individual conditions and as three subsets.

In the first phase of regression analyses, these three measures of physical health are predicted by a set of dummy-coded sociodemographic variables and selected interactions among these variables (see table 2 for actual dummy variables): (1) *sex*; (2) *race*; (3) *age*; (4) *marital status*; (5) *education* (years of school completed); and (6) *income* (received from all sources by the respondent and his or her spouse in the previous year). In the second phase of analysis, we look at the relationship between age and physical health for different levels of socioeconomic status defined in terms of education and income: (1) *upper* SES defined as 16+ years of education *and* income $\geq$ \$20,000 ($N$ = 606); (2) *upper-middle* SES defined as 12 to 15 years of education *and* income $\geq$ \$20,000 ($N$ = 1346); (3) *lower-middle* SES defined as either 0 to 11 years of education *or* income < \$20,000, *but not both* ($N$ = 964); and (4) *lower* SES defined as both 0 to 11 years of education *and* income < \$20,000 ($N$ = 701).

These socioeconomic groupings were created to enhance the clarity and economy of presentation of results while minimizing loss of information from the fuller set of education and income categories used in the initial analyses. The SES variable is *not* considered to measure prestige or anything other than the combination of current income and education. We recognize that the same level of education or income can mean different things in different age groups, but the rank ordering of SES levels remains invariant across age groups; it is the ordinal difference between SES levels that is of most interest in our and other analyses of socioeconomic differences in health. A variety of analyses indicated that the education trichotomy (0–11 vs. 12–15 vs. 16+ years) and income dichotomy (<\$20,000 vs. $\geq$\$20,000) captured most of the

significant variations in health explained by the larger classifications shown in table 2.

Education is temporally, and hence probably causally, prior to health at age 25 and up; income may be more reciprocally related to health. Results very similar to those reported here are obtained if education alone is used as an indicator of SES. Income partially mediates the effects of education, but has substantial additive effects and interactions with age even net of the parallel effects of education. Further, there is good reason to believe that much of the association between income and health reflects a causal impact of income on health (Mechanic 1968; Fox, Goldblatt, and Jones 1985; Wilkinson 1986). Thus, we feel it is appropriate to analyze the combined effects on health of both income and education.

## *NHIS Measures*

The third phase of the analysis utilizes data from the 1985 National Health Interview Survey (National Center for Health Statistics 1986) to replicate the ACL findings on the relationship between age and physical health across socioeconomic levels. The age and SES variables used here are the same as those described above. Physical health is measured by two sets of questions answered either by the subject person or another adult family member living in the same household. The first yields a sum of the number of *chronic health conditions* (of a given type) each person has had in the past 12 months (or "now" has in the case of impairments, and "ever" had in the case of circulatory conditions). The NHIS asked each household about only one of six types of health conditions: (1) skin and musculoskeletal conditions; (2) chronic impairments (e.g., paralysis, blindness); (3) digestive conditions; (4) circulatory conditions; (5) respiratory conditions; (6) or other miscellaneous health conditions. We have analyzed the number of chronic conditions both as a combined index for *all* persons in the NHIS survey (with each person's score representing the number of conditions of a given type reported) and as six separate measures of specific conditions for persons in a particular "condition list" subsample. Because results are similar for all types of conditions, we report in detail only results for the combined index.

*Activity limitation status* is a multi-item measure that classifies people into one of four groups, based on their degree of chronic limitation

in the performance of the "major activity" typical of persons in their age group, but only when such limitation is due to chronic ill-health problems: (1) "unable to perform major activity," (2) "limited in kind/amount of major activity," (3) "limited in other activities," and (4) "not limited."

## Results: 1986 ACL Survey

### *Additive Effects of Sociodemographic Variables*

Tables 1 and 2 summarize results of OLS multiple-regression analyses relating each physical health measure to *each* of the six major sociodemographic variables separately, and to *all* six sociodemographic variables simultaneously. Table 1 shows the total variance ($R^2$) in each health measure explained by each sociodemographic variable considered both alone (labeled the "gross" effects) and after controlling for the other five variables (labeled the "net" effects), as well as the total variance explained by the full set of independent variables. Table 1 in-

TABLE 1
Gross and Net Proportions of Variance ($R^2$) in Three Self-report Health Measures Explained by Sex, Race, Age, Education, Marital Status, and Income

| | Chronic conditions | | Functional status index | | Limitation of daily activities | |
|---|---|---|---|---|---|---|
| Variable | Gross | Net | Gross | Net | Gross | Net |
| Sex | .015* | .006* | .006* | .002$^+$ | .003* | .000 |
| Race | .004* | .001 | .003$^+$ | .001 | .002 | .001 |
| Age | .253* | .131* | .146* | .065* | .138* | .063* |
| Education | .112* | .011* | .074* | .008* | .064* | .002 |
| Income | .086* | .007* | .077* | .013* | .088* | .025* |
| Marital status | .059* | .000 | .035* | .001 | .027* | .002 |
| Total $R^2$ | | .297* | | .184* | | .180* |

*Source:* 1986 Americans' Changing Lives interview survey ($N$ = 3,617).
*Note:* All independent variables are dummy variables. See text and table 2 for definition of these variables.
$^+p \leq .01$. $^*p \leq .001$.

TABLE 2
Gross and Net Effects of Sociodemographic Variables on Three Self-report Health Measures

| Variable | Chronic conditions | | Functional status index | | Limitation of daily activities | |
|---|---|---|---|---|---|---|
| | Gross | Net | Gross | Net | Gross | Net |
| Sex | | | | | | |
| Female | .310* | .198* | −.105* | −.061° | −.123° | −.041 |
| Male | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |
| Race | | | | | | |
| Black | .216+ | .150° | −.034 | .017 | −.014 | .070 |
| Other nonwhite | −.166 | .042 | .144+ | .100 | .187° | .102 |
| White | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |
| Age | | | | | | |
| 25–34 | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |
| 35–44 | .292* | .311* | −.056° | −.074+ | −.119+ | −.167* |
| 45–54 | .648* | .630* | −.130+ | −.126+ | −.337* | −.358* |
| 55–64 | 1.250* | 1.146* | −.393* | −.349* | −.724* | −.665* |
| 65–74 | 1.586* | 1.383* | −.480* | −.371* | −.866* | −.706* |
| 75+ | 1.782* | 1.479* | −.963* | −.802* | −1.328* | −1.100* |
| Education | | | | | | |
| 0–8 years | 1.396* | .480* | −.622* | −.211+ | −.918* | −.176 |
| 9–11 years | .891* | .338* | −.341* | −.094° | −.571* | −.098 |
| 12 years | .405* | .114° | −.101* | .010 | −.254* | −.029 |
| 13–15 years | .360* | .244* | −.120+ | −.077° | −.200+ | −.105 |
| 16+ years | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |
| Marital status | | | | | | |
| Married | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |
| Widowed | 1.032* | −.001 | −.466* | .064 | −.628* | .180 |
| Divorced/ separated | .038 | −.053 | −.036 | .028 | −.075 | .066 |
| Never married | −.213+ | −.015 | .013 | −.007 | .075 | .064 |
| Income ($) | | | | | | |
| 0–9,999 | 1.033* | .457* | −.552* | −.322* | −.904* | −.695* |
| 10,000–19,999 | .658* | .310* | −.315* | −.178* | −.574* | −.443* |
| 20,000–29,999 | .334* | .222+ | −.115+ | −.074 | −.289+ | −.261+ |
| 30,000–39,999 | .118 | .147 | −.052 | −.065 | −.095 | −.138 |
| 40,000–59,999 | .062 | .137 | −.052 | −.076 | −.040 | −.096 |
| 60,000+ | —[a] | —[a] | —[a] | —[a] | —[a] | —[a] |

*Source:* 1986 Americans' Changing Lives interview survey ($N$ = 3,617).
*Note:* All entries are metric coefficients from the regression of each health outcome on each dummy variable classification alone (gross effects) and on all six dummy variable classifications (net effects). All coefficients are deviations from the omitted or reference category in *each* classification.
[a] Omitted or reference category in dummy variable classification. Other coefficients in classification estimate differences from this group (see text, p. 393).
° $p \leq .05$ + $p \leq .01$ * $p \leq .001$.

dicates that the additive combination of these six sociodemographic variables explains between 18 percent and 29.7 percent of the variance in the health measures. Among these variables, age, education, and income stand out as the most consistently important—having highly significant gross and (except in one instance) net effects on all health measures. In contrast, race, sex, and marital status have far smaller gross effects, and most or all of their gross effects disappear (see their net effects) once adjustments are made for age, education, and income. These results clearly suggest the importance of considering both age and socioeconomic status in attempts to predict or reduce morbidity and functional limitations.

Table 2 presents the metric regression coefficients from the regression of the three health measures on the dummy variable classifications representing each of the six independent variables in table 1. Each coefficient represents the estimated difference between persons in that category and those in the "omitted" or reference category of that variable; for example, on average, persons aged 75+ report 1.782 more chronic conditions than persons aged 25 to 34, and this difference remains 1.479 after adjustment for all other variables. The differences between other categories are seen by comparing their coefficients; for example, persons aged 75+ report about .20 more chronic conditions than persons aged 65 to 74 (i.e., $1.782 - 1.586 = .196$).

Table 2 shows several things. First, it indicates the direction of the relationship between the independent variables and the health outcomes. Thus, females are generally worse off than the omitted or reference category males on each health outcome; blacks and other nonwhites are generally worse off than whites; older persons are worse off than younger ones; persons with lower education and income are worse off than those with higher levels of these variables; and the unmarried tend to be worse off than the married. Note that high scores on the index of chronic conditions indicate poorer health, whereas high scores on the other two measures indicate better functional status.

Second, table 2 replicates patterns of gross and net effects observed in table 1. The gross and net differences in health across the categories of age, education, and income are both absolutely and relatively larger than those across race, sex, or marital-status groups. Looking at the net effects, for example, the differences between *adjacent* categories of age, education, or income are generally larger than the differences between the sex or the racial or marital-status groups; and the differences between the extreme groups on age, education, or income are many times

larger than the differences between the sex or racial or marital-status groups. Thus, the $R^2$ differences in table 1 reflect real differences in the magnitude of the effects of the variables, not just artifacts of age, education, and income being represented by a larger set of dummy variables.

Finally, the pattern of the effects of age, education and income is somewhat nonlinear in each case. This is most evident for income, where the differences in health are slight among the $20,000 and over categories, but those with incomes of less than $20,000, at or near poverty levels, are in markedly worse health. The effects of education are more linear, although the differences between the 12-year and 13 to 15-year age groups are consistently slight, with the less educated (0–8 or 9–11 years) generally being markedly worse off and the best educated (16+ years) generally being markedly better off than the two intermediate groups. Finally, the effects of age are also more linear, but vary by health outcome, with increases in chronic conditions being most marked in middle age (35–64), and decreases in functional status being most marked in old age (i.e., 75+).

## *Interactions of Age with Other Sociodemographic Variables*

We next examined how these age differences varied as a function of education, income, sex, race, and marital status. That is, using product interaction terms we tested for interactions between age and each of these variables net of the full additive model in tables 1 and 2. The results are important but can be briefly summarized. Again the combination of age and the socioeconomic variables stood out.

Table 3 shows the additional variance explained in each dependent health variable (net of the full additive model in table 2) by the set of product interaction terms formed by multiplying the age dummies by the dummies for each of the other demographic variables. The interactions of age with both education and income are more consistent, stronger, and more statistically significant than the interactions of age with sex, race, or marital status. *All six* of the interactions of age with education or income are highly statistically significant ($p \leq .001$). Only one of the nine other interaction tests in table 3 (between age and sex in predicting functional status) achieves that level of statistical significance, with two others achieving significance at the .01 level. The

TABLE 3
Proportions of Variance ($R^2$) in Three Self-report Health Measures Explained by Each Set of Interaction Terms When Added to the Full Additive Model in Table 2

| Interaction terms | Chronic conditions | Functional status index | Limitation of daily activities |
|---|---|---|---|
| Age × sex | .003$^+$ | .005* | .003 |
| Age × race | .006$^+$ | .004 | .004 |
| Age × education | .012* | .011* | .013* |
| Age × income | .013* | .017* | .020* |
| Age × marital status | .003 | .005 | .006 |

*Source:* 1986 Americans' Changing Lives interview survey ($N$ = 3,617).
*Note:* All interaction terms are dummy product variables. See text for definition of these variables.
$^+p \leq .01$ $^*p \leq .001$.

additional variance explained by the interactions between age and education or income, over and above their additive effects, is always between .011 and .020, rivaling or exceeding the net additive effects of the respective socioeconomic variables shown in table 1. In contrast, none of the other interactions with age accounts for more than .006 additional variance. (A table of the full regression equations for the age by education and age by income interactions is available from James S. House.)

Here and in the NHIS data we have checked further for possible higher-order interactions among sex, race, age, and socioeconomic status. Statistical tests are difficult because of the low numbers of older blacks of higher socioeconomic status, but examination of graphs (e.g., figures 1–5) within sex and race groups (i.e., black males, black females, nonblack males, and nonblack females) suggests that the interactions of age with socioeconomic status do not vary notably by sex or race or a combination thereof.

## *Interaction of Age and Socioeconomic Status*

Figures 1 to 3 display graphically a striking pattern of differences in the relation of age to health across four levels of socioeconomic status de-

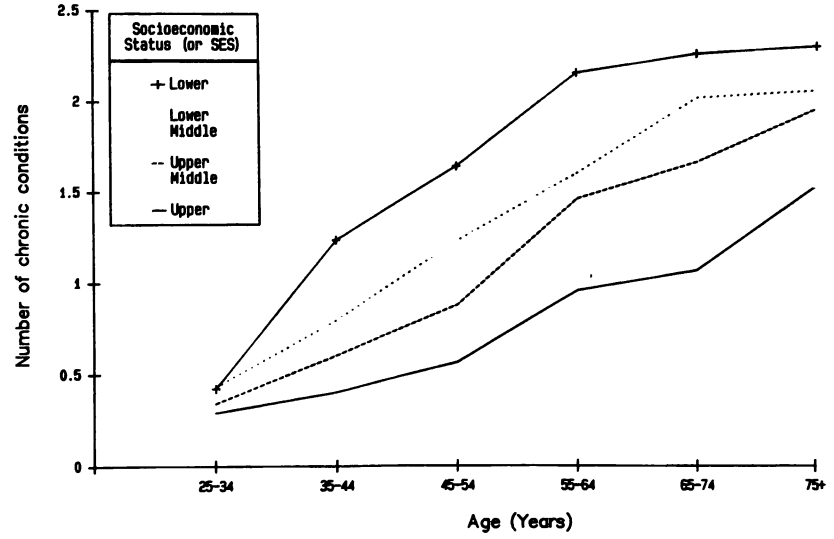


FIG. 1. Age by number of chronic conditions within levels of socioeconomic status. (See text for definition of SES levels in terms of education and income.) *Source:* 1986 Americans' Changing Lives interview survey data ($N$ = 3,617).

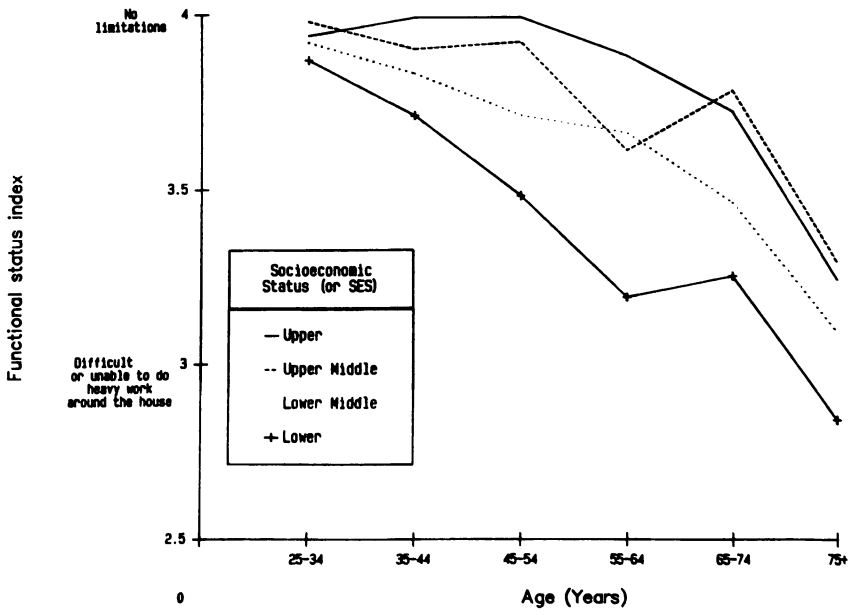


FIG. 2. Age by functional status index within levels of socioeconomic status. *Source:* 1986 Americans' Changing Lives interview survey data ($N$ = 3,617).

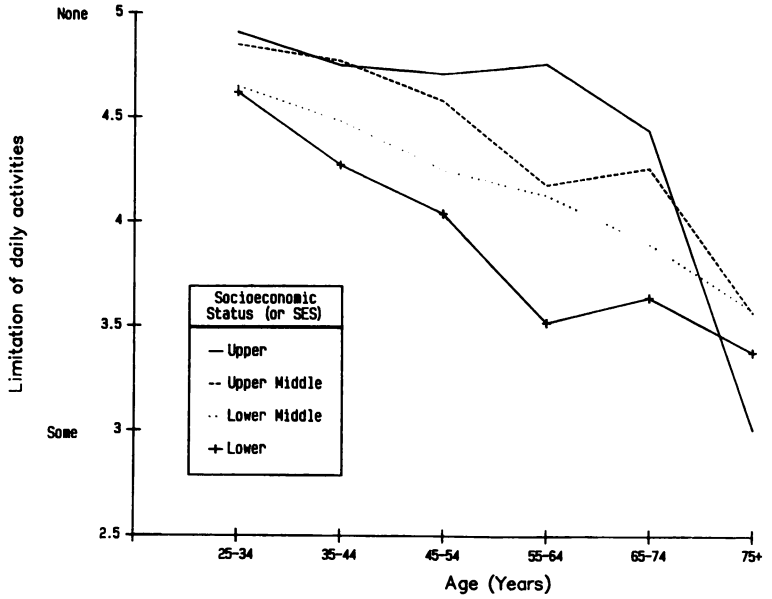


FIG. 3. Age by degree of limitation of daily activities within levels of socioeconomic status.
*Source:* 1986 Americans' Changing Lives interview survey data ($N$ = 3,617).

fined by education and income, as indicated above. Figure 1 shows that significant numbers of chronic conditions are manifest in the American population by middle adulthood, but the relation of the prevalence of chronic conditions to age varies markedly by socioeconomic status. In early adulthood (ages 25–34), there are no significant ($p \leq .01$) socioeconomic differences in prevalence of chronic conditions—all socioeconomic groups having an average level of less than 0.5 conditions per person. However, marked socioeconomic disparities are evident in early middle age (35–44), are larger still among persons of middle (45–54) and early-old age (55–64 and 65–74), and then are smaller again among persons of older age (75+). We have replicated the results in figure 1 for each condition and for three subsets of chronic conditions: (1) "potentially life threatening" (cancer, heart attack/trouble, stroke), (2) "serious chronic" (arthritis, lung disease, hypertension, diabetes, urinary incontinence), and (3) "other" (fractures and foot problems). The pattern of results in figure 1 is generally replicated in each case, indicating that these results are not unique to, or an artifact of, particular more or less serious health problems.

In figure 1 the lowest socioeconomic stratum manifests a prevalence of chronic conditions at ages 35 to 44 that is not seen in the highest socioeconomic stratum until after age 75. Prevalence of chronic conditions virtually peaks at ages 55 to 64 in the lowest socioeconomic stratum, at ages 65 to 74 in the lower-middle stratum, but not until after age 75 in the two highest socioeconomic strata. We have also examined these patterns in five-year age groups from 60 to 64 through 85+, analyses made possible by the oversampling of persons aged 60 and over. The results suggest that the process of convergence largely occurs between ages 70 and 79, except for the ultimately complete convergence of health status at death.

In sum, figure 1 suggests considerable postponement of morbidity in the highest socioeconomic group, where the mean prevalence of the 10 chronic conditions included in our measures is below 0.5 until age 54, and below 1.0 until age 75. In contrast, the mean prevalence of chronic conditions rises sharply in the lower socioeconomic group between ages 25 and 54. The middle socioeconomic groups manifest an intermediate pattern.

Figures 2 and 3 show the results for two indicators of functional status. Again, the pattern of differences by socioeconomic status in the relation of age to health is striking: socioeconomic differences are virtually nonexistent at ages 25 to 34, increase markedly through ages 55 to 64, then begin to converge. For the high socioeconomic group, it is not until age 75 and over that prevalence of substantially diminished functional capacity is evident. The upper-middle socioeconomic group has a pattern almost identical to the high socioeconomic group in both figures 2 and 3 except for a nonmonotonic drop in the 55 to 64-year-old group. In contrast, the lower socioeconomic groups manifest an essentially linear decline in functional capacity, with the lowest socioeconomic group manifesting declines of more than a full point on each measure prior to age 65—levels not observed in the higher socioeconomic groups until after age 75. Thus, it appears that upper socioeconomic groups substantially postpone functional limitations into the last years of life, but the lower socioeconomic groups experience significant functional limitations quite early.

Appendix A shows the means and standard errors (adjusted for the weighted, clustered, stratified sample design) for the data in figures 1 to 3. For clarity of presentation, confidence intervals are omitted on figures 1 to 3. The data in Appendix A show, however, that there are few or no

significant ($p \leq .01$) differences between socioeconomic groups at ages 25 to 34 and 75+, with most differences, especially between the upper and lower socioeconomic groups, being highly significant in the 35 to 74 age range.

Further analyses (not reported in graphs or tables) show that the postponement of morbidity and disability in the highest SES strata and the absence thereof in the lower SES strata is even more marked in terms of more severe levels of morbidity and functional limitations. Across all SES groups, only 0.5 to 1.4 percent of persons report *three* or more chronic conditions at ages 25 to 34. In the highest SES group, the prevalence of this level of multiple morbidity never exceeds 16 percent, even at ages 75+, whereas 12 percent of the lowest SES strata report three or more chronic conditions at ages 35 to 44, rising to 26 percent by ages 45 to 54, and 39 percent prior to age 65. Similarly, the percentage of persons who are unable to walk a few blocks or climb a few flights of stairs without difficulty is 3 percent or less across all SES groups at ages 25 to 34. In the upper SES stratum, this percentage rises to only 5 percent at ages 65 to 74 and 9 percent at ages 75+; but in the lowest SES stratum 12 percent of persons aged 35 to 44 report this level of functional limitation, rising to 29 percent at ages 55 to 64 and over 40 percent at ages 75+.

## Results: 1985 NHIS Survey

Before beginning to interpret the pattern of results in figures 1 to 3, a pattern not previously reported, we sought to replicate the analyses of the 1986 ACL data in the 1985 National Health Interview Survey (NHIS), which included very similar measures of reports of chronic conditions and limitation of daily activities. Figures 4 and 5 present data from the 1985 NHIS, which parallel the ACL data presented in figures 1 to 3. The results in figures 4 and 5 are strikingly similar to those in figures 1 and 3, except that the upper-middle socioeconomic group more nearly resembles the highest group and that there is perhaps a little more convergence across socioeconomic groups at age 75+. Again, we see the two lower socioeconomic strata manifesting in the middle age range (45–64) levels of chronic conditions and limitation of functional capacity that are not evident in the higher socioeconomic groups until after age 75, if then. We have replicated figure 4 for each of the

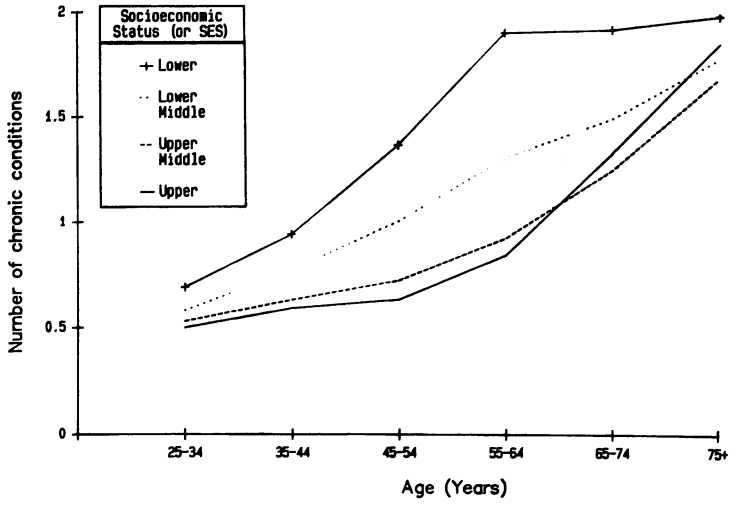


FIG. 4. Age by number of chronic health conditions within one of six health domains and within levels of socioeconomic status.
*Source:* 1985 National Health Interview Survey data ($N$ = 55,690).

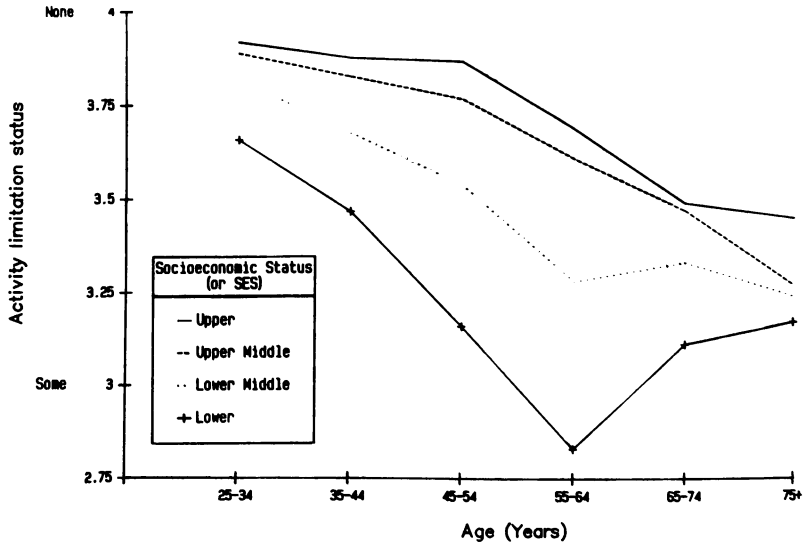


FIG. 5. Age by activity limitation status within levels of socioeconomic status.
*Source:* 1985 National Health Interview Survey data ($N$ = 55,690).

separate classes of chronic conditions in the NHIS. Our results show similar patterns for all forms of morbidity, with the interaction of age and socioeconomic status being more pronounced for chronic impairments, respiratory conditions, and miscellaneous conditions, and somewhat less pronounced for skin or musculoskeletal, digestive, and circulatory conditions.

Overall, the National Health Interview Survey yields results quite similar to the ACL survey results. As usually occurs in cross-validation on larger samples, the NHIS results are slightly less strong, but the essential patterns remain. Analyses not reported here show also that income is somewhat more important, relative to education, in the NHIS as opposed to the ACL data.

## Discussion

These results, from two large (ACL $N = 3{,}617$, NHIS $N = 55{,}690$) and independent representative samples of the population of the contiguous 48 states, suggest that the vast bulk of what might be termed excess or preventable morbidity and functional limitations in the U.S. population—that is, morbidity and functional limitations prior to age 75 at least—is concentrated (both absolutely and relatively) in the lower socioeconomic strata of our society. Were this situation to change so that the relation of age to health in the lower socioeconomic status groups approximated what is found among the socioeconomically more advantaged, substantial progress would occur toward the goal of postponing morbidity and functional limitations into the last years of the human life span for the entire population. Significant issues and problems of health and health care would remain among the "older and oldest" old (i.e., those aged 75+ or certainly 80+). These issues and problems appear to be somewhat less differentially distributed by socioeconomic status, although socioeconomic differences are likely to persist into old age in terms of more severe levels of morbidity and disability and may still be influenced by factors that operate to produce the socioeconomic differentials in the relation of age to health up to age 75. Thus, understanding the mechanisms that have generated socioeconomic differences in the relation of age to health at least up to age 75 could provide a basis for substantially improving health and perhaps re-

ducing health-care expenditures by increasingly postponing morbidity and functional limitations into the last years of the human life span.

## *Issues of Causality*

Before discussing these potential mechanisms, let us note several methodological concerns. We have already discussed issues about the causal direction of relations between SES and health, and indicated why it seems reasonable to posit a substantial causal effect of SES on health, while not ruling out some degree of reverse causation. These logical arguments are consistent with initial analyses just completed on 2,867 respondents in our ACL survey (over 83 percent of all surviving 1986 respondents), who agreed to be reinterviewed in the first half of 1989. Lower SES groups manifest significant declines from 1986 to 1989 in a number of self-report indicators of health status, and these declines are largest and most statistically significant in middle and early old age (i.e., 35 to 74). In contrast, higher SES groups report no significant declines in health over this 2.5-year interval. (See House et al. [1990] for a fuller report of these analyses.)

## *Problems of Aging, Cohorts, and History*

The cross-sectional nature of the results reported here raises a set of issues for their interpretation, and for further attempts to identify explanatory mechanisms or factors. We are observing differences across age groups at a given point in time. These could reflect cumulative changes in, or "aging" of, individuals over their life course, or differences between age cohorts, which have been established at some point (e.g., in early childhood or adulthood) and which persist as they age through the life course. An aging interpretation of our data seems more plausible than a cohort interpretation at this point, although single cross-sectional surveys are not adequate to decide this issue. The within-individual changes between 1986 and 1989 in the ACL study that we have just noted are consistent with an aging interpretation. A cohort interpretation would also have to account for a marked rise and fall in socioeconomic differences in health over cohorts born between about 1910 and 1960. The shifting relative importance of acute infectious versus chronic diseases over this period, coupled with shifts in their respective relations to SES, provide some basis for such a cohort-

based explanation of the data in figures 1 to 5, albeit still less parsimonious and plausible than an aging interpretation. It is also implausible that the variations we find in health by socioeconomic status and age are historically unique to the 1980s, although these differences may have been exacerbated in the 1980s by economic and political events that increased socioeconomic inequalities.

Firmer resolution of these issues will become possible only as we obtain longer-term longitudinal data. Analyses of repeated cross-sectional surveys allow strong *inferences* about aging effects, but only longitudinal measures on the same individuals can finally show that socioeconomic differences in health increase within given cohorts as they age, or that the duration of morbidity and functional limitations is actually compressed in some socioeconomic groups more than others. Cross-national analyses would help to determine whether these results are unique to the United States or a subset of nations, or are typical of all nations. Further analyses of existing repeated cross-sectional surveys such as the NHIS can help to specify whether the pattern of results in figures 1 to 5 is equally characteristic of earlier decades and age cohorts.

## *Potential Explanatory Mechanisms*

Whether the differences in health by SES and age that we seek to explain reflect aging, cohort differences, or unique historical (sometimes termed "period") effects, we must also attempt to understand the more specific processes or mechanisms that create these differences. An adequate theory of the data in figures 1 to 5 must explain why socioeconomic differentials are small in early adulthood, greatest in middle and early old age, and relatively small again in later old age. The relative biological robustness of human beings in early adulthood must account in part for the relatively low level of health problems at that age, and the modest socioeconomic variation therein. Processes of selective mortality undoubtedly account for some of the convergence in older age. The sickest people in the middle-aged portions of the population, who are most likely to be of lower socioeconomic status, are likely to die prior to age 65 so that on average the prevalence of morbidity and functional limitations in the lower socioeconomic strata is usually no greater, and sometimes less, among persons over age 65 than those below age 65. In contrast, the higher SES strata only manifest high levels of health problems in the older age ranges. Again, long-term longitu-

dinal data are crucial to evaluating the extent of selective mortality effects.

We have hypothesized, however, that variations by age and socioeconomic status in the levels and impact of psychosocial and environmental risk factors (i.e., health behaviors such as smoking, eating, drinking, or exercise; acute and chronic psychosocial stress, self-efficacy, or control; social relationships and supports; and physical, chemical, and biological hazards at work) account for a large part of the variations in health by age and socioeconomic status evident in figures 1 to 5. Socioeconomic variation in the levels of many of these risk factors appears to be relatively small in early adulthood, greater during middle and early old age, and then smaller again in older age. The average disadvantage of lower socioeconomic groups on these variables is likely to become cumulatively greater throughout middle and early old age, and then diminish with the advent of retirement and government guarantees of income maintenance and health care available to all citizens in our society by age 65. Combined with individuals' increasing length of exposure to risk factors and increased biological vulnerability to them as they grow older, these social processes should explain much of the variation we observe in the postponement of morbidity and functional limitations until late life.

To the mechanisms already cited, we might add the effects of differences in access to medical care itself and in biological vulnerability due to early life experiences. The last century has seen continuing efforts toward equalizing access to medical care, yet socioeconomic differences in access have persisted (Davis, Gold, and Makuc 1981) and have been exacerbated in the past decade as persons of working age have become increasingly likely to lack health insurance.

Although socioeconomic differences in physical health appear generally small or nonexistent in our data in young adulthood (ages 25 to 34), we know that such differences are strong around the time of birth, as evident in prenatal, neonatal, infant, and child morbidity and mortality (Neresian 1988). Because socioeconomic origins predict adult socioeconomic status (Blau and Duncan 1967), residues of this earlier period may persist into early adulthood in forms that are not manifest in terms of chronic disease or functional status, but that constitute risk factors for the development of chronic disease and functional health problems in midlife (i.e., ages 35 to 55). These residues could include personality and lifestyle differences (discussed above) or compromised

bodily functioning or nonmorbid pathogensis (e.g., impaired immune function, musculoskeletal infirmities, nonmorbid arteriosclerosis or carcinogenesis); and they may represent a combination of genetic and environmental influences (Forshdahl 1977).

### *Summary Directions for Future Research*

Further research needs, then, to go in two directions. The present analyses must be extended over time and space, primarily in terms of longitudinal studies of individuals and secondarily in terms of replicated cross-sectional studies on cross-national populations and on the American population at different points in time. Additionally, future research must assess the explanatory power of the potential mechanisms discussed here, as we are now doing in our ACL data (House et al., 1990). Both lines of research will contribute to clarifying our scientific understanding and hence our ability to utilize this understanding in formulating policies to address socioeconomic differentials in the relation of age to health.

## Conclusion

To the extent that we already have seen, or may see in the future, improvements in the health-related psychosocial profile of the entire population (e.g., fewer deleterious health behaviors, more adequate patterns of social relationships, reduction in occupational health hazards of all types, better access to primary and preventive health care) we may increasingly be able to postpone morbidity, disability, and mortality into the last years of the human life span. *If* we can postpone morbidity and disability more rapidly than we postpone mortality or increase life expectancy, we may finally begin to approximate the utopian scenario of Fries (1980) and others regarding the "compression" of morbidity and disability into the last years of a finite human life span.

Our results suggest that reduction of socioeconomic differentials in health in middle and early old age must be an essential component of any effort to further postpone morbidity, disability, and mortality. Thus, efforts to deal with problems of aging and health must attend much more than heretofore to socioeconomic differentials. Conversely,

efforts to reduce socioeconomic inequalities in adult health must increasingly focus on middle and early old age.

Understanding the psychosocial and biomedical variables or mechanisms that produce the age and SES differentials we observe, and acting to modify those variables or mechanisms, represents an important strategy for reducing SES differentials and hence postponing morbidity, disability, and mortality. However, we may ultimately have to reduce socioeconomic inequalities themselves in order to reduce socioeconomic differentials in health and the relation of age to health. It is notable that over the past century, as we have identified and increasingly equalized the distribution by socioeconomic status of factors affecting health (e.g., improved sanitation and nutrition, vaccination and antibiotic drugs, medical care in general), new factors have emerged as important (e.g., health behaviors) and they have come over time to be distributed in such a way as to maintain socioeconomic differentials. Earlier in this century smoking, lack of exercise, and high-fat diets were more prevalent in higher SES groups, but as their impact on health has become greater, or at least more clearly recognized, they have become relatively more prevalent in lower SES groups. Similarly, as various diseases (e.g., coronary heart disease in the first part of the century and AIDS in the latter part) have come to be increasingly important determinants of morbidity, disability, or mortality, their prevalence and incidence have risen in lower socioeconomic groups.

As Lieberson (1985) has argued, to find more proximal intervening variables and mechanisms linking a more distal cause to a given outcome is not necessarily to explain the full causal dynamic linking the distal variable to the outcome. The impact of socioeconomic status on health may be like a powerful river. If you identify its present course and alter or block that course, it may simply find a new route to its destination. The variety of advantages in power, prestige, knowledge, and monetary resources (or what economists such as Fuchs [1986] and Grossman [1975] term human and nonhuman capital) that accrue to members of higher SES strata may repeatedly enable them to avoid health hazards more readily or to mobilize health-protective factors, no matter what hazards or protective factors are most important at a given time. Some reduction in socioeconomic inequality itself may be necessary to reduce its persistent effects on health and on the relation of age to health.

APPENDIX A
Means, Standard Errors (SE), and Number of Cases for Health Outcomes by Age and SES*

| Years of age | Number of chronic conditions | | Functional status (1–4)† | | Daily activities (1–5)‡ | | Unweighted (*N*) |
|---|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | Mean | SE | |
| 25–34 | | | | | | | |
| Lower SES | .42a§ | .092 | 3.87a§ | .057 | 4.62ab§ | .094 | 10[illegible] |
| Lower middle | .43a | .047 | 3.92a | .031 | 4.65a | .062 | 272 |
| Upper middle | 34a | .047 | 3.98a | .013 | 4.85 bc | .025 | 245 |
| Upper SES | .29a | .060 | 3.94a | .043 | 4.91 c | .044 | 123 |
| 35–44 | | | | | | | |
| Lower SES | 1.23a | .194 | 3.71a | .099 | 4.27a | .131 | 90 |
| Lower middle | .79ab | .101 | 3.83a | .042 | 4.48ab | .109 | 157 |
| Upper middle | .60 bc | .054 | 3.90ab | .034 | 4.77 c | .036 | 245 |
| Upper SES | .40 c | .083 | 3.99 b | .011 | 4.75 bc | .081 | 100 |
| 45–54 | | | | | | | |
| Lower SES | 1.63a | .291 | 3.48a | .166 | 4.04a | .206 | 97 |
| Lower middle | 1.22a | .199 | 3.71a | .101 | 4.25ab | .157 | 98 |
| Upper middle | .87ab | .094 | 3.92ab | .030 | 4.58ab | .091 | 135 |
| Upper SES | .56 b | .083 | 3.99 b | .011 | 4.71 b | .110 | 59 |
| 55–64 | | | | | | | |
| Lower SES | 2.14 | .145 | 3.19 | .091 | 3.52a | .147 | 232 |
| Lower middle | 1.59a | .096 | 3.66a | .069 | 4.13 b | .087 | 214 |
| Upper middle | 1.45a | .127 | 3.61ab | .101 | 4.18ab | .214 | 178 |
| Upper SES | .95 | .143 | 3.88 b | .051 | 4.76 | .058 | 61 |
| 65–74 | | | | | | | |
| Lower SES | 2.24a | .081 | 3.25a | .069 | 3.64a | .102 | 364 |
| Lower middle | 2.00ab | .097 | 3.46ab | .069 | 3.90ab | .091 | 239 |
| Upper middle | 1.65 b | .145 | 3.78 c | .051 | 4.26 bc | .125 | 120 |
| Upper SES | 1.06 | .159 | 3.72 bc | .088 | 4.44 c | .153 | 42 |
| 75+ | | | | | | | |
| Lower SES | 2.28a | .122 | 2.84a | .097 | 3.38a | .082 | 259 |
| Lower middle | 2.04ab | .128 | 3.09ab | .095 | 3.58a | .141 | 140 |
| Upper middle | 1.94ab | .267 | 3.29 b | .161 | 3.57a | .295 | 37 |
| Upper SES | 1.52 b | .209 | 3.24ab | .267 | 3.01a | .606 | 10 |

*Source:* 1986 Americans' Changing Lives interview survey ($N$ = 3,617).
* For figures 1 to 3.
† 4 = good health.
‡ 5 = not limited.
§ Means for a particular health variable (within a given age group only) that have the same letter are *not* significantly different from each other, $p \leq .01$ level.

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