DEMOGRAPHIC AND ECONOMIC CORRELATES OF HEALTH IN OLD AGE*

JAMES P. SMITH AND RAYNARD KINGTON

In this paper we examine disparities in the ability to function among older Americans. We place special emphasis on two goals: (1) understanding the quantitatively large socioeconomic status-health gradient, and (2) the persistence in health outcomes over long periods. We find that there exist strong contemporaneous and long-run feedbacks from health to economic status. In light of these feedbacks, it is important to distinguish among alternative sources of income and the recipient of income in the household. This research also demonstrates that health outcomes at old age are influenced by health attributes of past, concurrent, and future generations of relatives. Finally, we find that the demographic and economic differences that exist among them explain functional health disparities by race and ethnicity, but not by gender.

In this paper we examine disparities in functional health among older Americans using an important new survey: the Asset and Health Dynamics among the Oldest Old (AHEAD). AHEAD places equal emphasis on high quality measurement of three life domains required for this research: health, economic status (wealth and income), and demographic structure (the number and health of close family members). A central question we address in this paper involves the extent to which the demographic and economic differences that exist among older people account for functional health disparities by gender, by race, and by ethnicity.

Economic and demographic forces are key correlates of health status in old age. The strong inverse relationship between socioeconomic status (SES) and health apparently cuts across racial, ethnic and gender lines (Feinstein 1993; Kaplan and Keil 1993; Preston and Taubman 1994). There are many basic questions about the relationship between the level of economic resources and health status in old age that remain unanswered, but three are addressed in this paper. The first is how to measure appropriately a household's total resources. To understand the reasons underlying the SES-health relationship, we must distinguish among alternative sources of income and the recipient of the income in the household. In addition, compared with income, wealth may be a better measure than income of financial resources—especially among the elderly (Hurd 1989). The second question concerns the strength of the SES-health relation at different segments of the economic strata. Finally, the SES-health relation is often implicitly viewed as causal, implying that additional income or wealth would lead to improvements in health. We argue here that many components of a household's economic resources reveal important contemporaneous (current period) and long-run feedbacks from health to economic status.

Similarly, health status at older ages may reflect health at earlier stages of life, even back to childhood or *in utero* (Barker 1990), and also may be correlated across generations (Preston and Elo 1992). The reasons for this correlation include shared genetic endowments with some families intrinsically "healthier" than others, good childhood health induced by parental economic resources that persists into old age, and common social and geographic environments. A unique aspect of AHEAD's demographic constructs is that they proxy the health of close relatives spanning three generations: parents, siblings and children.

We divide the paper into five sections and a conclusion. In the first we sketch the implications of the theoretical model, and in the second we describe the survey and demographic differences in one salient aspect of health in old age: the extent of functional limitations. In the third section we summarize the main results of the empirical model. In the section that follows we highlight the differential impact of alternative sources of income and wealth on health outcomes. In section five we summarize the implications of this research for gender, racial, and ethnic health disparities.

THEORETICAL FRAMEWORK

The standard economic model of health, largely developed by Grossman (1972), can be used to illustrate a few key principles that guide our analysis. This relationship starts with the health production function:

$$H_t = f(H_{t-1}, G_0, B_t, MC_t, ED). \quad (1)$$

Health in period t, H_t, is the result of the stock of health in the period $t-1$, H_{t-1}, depreciation, and investments to improve health in the previous period. Health is produced by a number of different inputs, including the use of medical care (MC_t), the adoption of good personal health behaviors (exercise), and the avoidance of bad ones (B_t; e.g., smoking and excessive drinking), and a vector of family education levels

* James P. Smith, Senior Economist, RAND, 1700 Main Street, Santa Monica, CA 90407-2138; e-mail: James_Smith@RAND.org. Raynard Kington, University of California–Los Angeles and RAND. The excellent programming assistance of Iva Maclennan and David Rumpel is greatly acknowledged. We would like to thank Michael Hurd and the anonymous reviewers for helpful comments. This research was supported by Grant PO1-AG08291 and Grant RO1-AG12394 awarded by the National Institute on Aging.

(*ED*). These risk factors may include the behaviors of close family members and, if the data are available, of other frequent contacts. The stock of health also may enter into the health production function because individuals in better health may be more able to translate other inputs into more productive health investments. Finally, family background or genetic endowments (G_o) also enter the health production function. If ignored, the existence of these often unobserved background factors may bias estimates of this production function. For example, a person who has been sickly throughout his/her life may require more medical care.

Perhaps the fundamental insight of this approach is that health is a stock. The current inputs and behaviors chosen are investments that produce increments to the stock of health. If these increments are affected by current inputs and behaviors, today's health stock is determined by the entire history of current and past inputs and behaviors. A corollary implication is that additional current economic resources may not have a quantitatively large impact on the current stock of health, especially for the age groups in this research. Additional economic resources may increase health care utilization or may induce good health behaviors, but these behavioral changes may be slow to adapt. Even if these behaviors were altered instantaneously, they can have a direct effect only on health investments and not on health capital.

Similarly, the budget constraint that limits household choices is a lifetime budget, so households are not limited solely by their current period resources. Financial resources in any period consist of the earnings W_t of all household members, retirement-related income R_t, government transfers T_t, and asset income A_t. An important consideration is that each of these income sources may be affected by the stock of health. Most directly, healthier people can work longer hours in any given week and more weeks during a year, leading to higher earnings.[1] Similarly, poor health may trigger the receipt of means-tested government transfer income.

The net result is that health enters into the model in two ways, producing possible two-way feedbacks between health and income. Good health is an outcome that people desire, and higher income enables them to purchase more of it. In addition, good health may facilitate the receipt of some income sources (earnings) while discouraging the receipt of others (transfers). Current health risk behaviors also may be affected by the current stock of health. For example, due to recent health deterioration, respondents may have stopped smoking or drinking; so those respondents in the worst current health do not engage in poor risk health behaviors.

From the production function and budget constraint, we can solve the reduced form demand function for health:

$$H_t = H^*(H_{t-1}, P_{mc}, P_o, ED, E_t, R_t, A_t, G_o). \quad (2)$$

Eq. (2) expresses current health as a function of the price of medical care (P_{mc}), the price of other inputs (P_o), education of each family member (*ED*), and all sources of household income. This is a frequent expression of a reduced form, but two issues raise concerns. The first results from the inclusion of lagged health in the function. Last period's health is determined by last period's set of prices; so solving sequentially, current health is more correctly a function of all past prices and past incomes. This argument implies that we can be solve Eq. (2) sequentially as

$$H_t = H^*(\tilde{P}_{mc}, \tilde{P}_o, ED, \tilde{E}_t, \tilde{R}_t, \tilde{A}_t, G_o), \quad (3)$$

where the ~ now indicate a time series vector of values.

The second issue involves feedbacks from health to income sources. An important distinction exists between contemporaneous (current period) feedbacks and the full lifetime sequence of such feedbacks. Using Eq. (2), we find a contemporaneous feedback when current health status directly affects the amount of current income received. By allowing us to separate income into its distinct components, even the cross-sectional AHEAD data permit us to make progress on the contemporaneous relationships. Some income components are contaminated by contemporaneous feedbacks from health to economic status, while (at least in this age group) other income components are largely free of any contemporaneous feedbacks. At a minimum, our data will allow us to mitigate the contemporaneous feedbacks from health to income.

Eq. (3) demonstrates that eliminating contemporaneous health feedbacks is only part of the problem. Prior health conditions may affect past income, which in turn may alter current income receipts. To illustrate, periods of poor health in middle age, by reducing earnings, could have negative implications for pension and social security income received during retirement. Because individual health status is positively correlated even across quite different ages, any correlation of retirement income and current health may flow from past health to current retirement income. To monitor the evolution of health outcomes over the life cycle, we ideally would like to know the entire lifetime sequence of health stocks, health behaviors, prices, and components of incomes and wealth. We argue here, however, that even the cross-sectional AHEAD survey can provide insights on the relative importance of these long-term health feedbacks to income.

DATA SOURCE, STATISTICAL MODELS, AND EXPLANATORY VARIABLES

This research is based on the first wave of the recently released AHEAD. AHEAD includes 6,052 households (8,223 individuals) with a least one individual age 70 or over in 1994. To increase the representation of the minority population, there was a 2:1 oversampling of African-American and Hispanic households, as well as an oversampling of Florida residents. We weight all analyses in this paper to reflect this survey sampling frame. AHEAD focuses on one of the key concerns in this age group: the relationship of life cycle changes in physical and cognitive health in old age to wealth accumulation and decline. AHEAD includes modules on de-

[1] Healthier people may have more incentive to invest in other forms of human capital and therefore command higher wages in the labor market.

mographic characteristics; economic resources and labor force activity; health status, functioning, utilization, and expenditures; and intergenerational transfers and family structure. Individual-level modules were given to both the age-eligible respondent (70 or more) and the spouse. Our analyses are limited only to those 7,114 individuals who were at least 70 years old at the time of the survey.

AHEAD contains a very comprehensive and detailed set of questions measuring household resources. Household income and household wealth may have sizable independent effects on the likelihood of experiencing good health. Greatly improved wealth data[2] were obtained by use of bracketing techniques by which individuals who did not know or who were unwilling to reveal specific dollar amounts in response to financial questions were prompted to provide upper and/or lower bounds on the amounts. These bracket questions reduced item nonresponse to wealth questions among wealth holders by almost 75%, and have been shown to produce more accurate estimates of missing values (Smith 1995).

In this paper we examine an important aspect of health during old age: the extent of functional limitations. Because it measures the ability to perform a range of tasks necessary to take care of one's self and one's family, functional status is a particularly relevant health outcome at older ages (Kane and Kane 1981; Wilson and Cleary 1995). First, the interactive impact of older people's multiple chronic conditions on health is not proxied simply by disease prevalence and severity. Functional status also captures a critical dimension of the ability to live independently in the community, especially with increasing risks for disabling chronic diseases. Finally, functional status is an useful index of the need for assistance that must be provided by family, friends, or government programs.

A functional status score was created based on the answers to 11 questions about the ability to perform a series of functional activities (see Appendix for a list of specific activities). Respondents could answer with one of the following options: (1) not at all difficult, (2) a little difficult, or (3) a lot of difficulty. A functional status index was created by summing responses to all who answered 1–3 and rescaling to a 0–100 scale, with a value of 0 implying no limitation in any activity and a higher score indicating worse function.[3] Even though our sample population is restricted to those age 70 and over, age variation within this sample can affect demographic differences in health. Because women live longer than men, our female sample is older. This gender age disparity in AHEAD alone could make it appear that women were less healthy than men. Therefore, all functional scores listed in Table 1 are adjusted to conform to the white male birth cohort distribution.[4]

Difficulty in functioning is accentuated by the onset, duration, and intensity of many chronic diseases. Prevalence rates for chronic conditions are obtained in AHEAD from self-reports on whether the respondent has hypertension, diabetes, cancer, lung diseases, a heart condition, a stroke, heart attack (during the past five years), angina, emotional disorders, arthritis (during the past year), a broken hip, cataract surgery, incontinence, frequent pain, or other health problems.[5]

Table 1 shows large disparities in functional ability across gender, racial, and ethnic lines. Even after we age adjust the data, white women score much worse than white men in their ability to function, and both minority groups experience greater functional difficulty than whites do. These quite dramatic demographic disparities persist even within specific chronic conditions. The patterns across chronic conditions are consistent with a priori expectations. Difficulty in functioning is particularly severe among those with broken hips and strokes, but less problematic for those with hypertension.

AN EMPIRICAL MODEL OF FUNCTIONAL LIMITATIONS

Our analyses examine the extent of functional limitations. Because the distribution of functional status scores is bounded by 0 and 100 with a large percentage of observations at 0, we estimate functional status scores with an analytic technique appropriate for dependent variables with this type of distribution: a two-limit Tobit regression model which explicitly recognizes that the outcome cannot be less than 0 or greater than 100.[6]

[2] In addition to housing equity, assets were separated into the following eleven categories: other real estate; vehicles; business equity; IRA or Keogh; stocks or mutual funds; checking, savings, or money market funds; CDs, government savings bonds or treasury bills; other bonds; other assets; and other debt.

[3] There is a growing literature addressing the complex manner in which various functional limitations are interrelated. There is little consensus, however, as to how or whether these measures should be aggregated into a single index. Following the creation of other similar indices in the published literature, we have created a global functional index in which each activity, from advanced to basic activities of daily living, is given equal weight. The mean score on the functional status index was 13.1, the standard deviation was 15.4, and the range was 0–100, with a higher score indicating worse function.

[4] The only covariate included in these models is a set of birth cohort dummy variables. Using these models, we impose the white male birth cohort distribution on all other groups and obtain predicted age-adjusted prevalence rates.

[5] Racial and gender patterns in disease prevalence are consistent with other published data (e.g., Diehl and Stern 1989; Manton, Patrick, and Johnson 1987). Blacks report higher rates of hypertension, stroke, diabetes, and arthritis, and lower rates for lung diseases, cancer, and cataract surgery. Hispanic men score lower than black men in the prevalence of these health conditions (with arthritis, pain, and heart attacks the major exceptions), and in a number of prominent cases their prevalence rates are lower than those reported by white men. In contrast, Hispanic women are more comparable to black women, and their health is a good deal worse than that reported by Hispanic men.

Gender differences in chronic conditions are a mixed bag, with women having higher prevalence in some conditions and men in others. For all demographic groups, women have higher rates of hypertension, emotional or psychological problems, arthritis, incontinence (except for black women), cataract surgery, and pain; men are uniformly more troubled by cancer, lung diseases, and strokes.

[6] The Tobit model constrains effects of covariates to be the same for the probability of having no functional limitation and for the increase in the number of limitations given that the person has at least one limitation. A two-part model relaxes this constraint. In the two-part model, the probability of reporting any limitation is estimated by weighted probit regression.

TABLE 1. FUNCTIONAL STATUS SCORES BY MEDICAL CONDITIONS BY RACE AND SEX, AHEAD SAMPLE (AGES 70 AND OVER, AGE ADJUSTED)

	White Men	White Women	Black Men	Black Women	Hispanic Men	Hispanic Women
Full Sample	6.9	11.2	10.6	10.5	14.3	14.9
BY MEDICAL CONDITIONS						
High blood pressure	7.6	12.5	13.0	15.9	7.7	18.0
Diabetes	9.9	16.7	15.7	19.1	15.5	17.1
Cancer	8.8	13.2	12.9	14.0	7.5	18.5
Lung diseases	12.5	18.3	13.1	23.5	10.7	26.8
Heart condition	8.9	16.2	17.0	21.6	14.2	20.9
Heart attack	11.8	21.7	22.9	22.9	17.8	38.1
Angina	13.8	23.5	31.1	24.5	17.6	26.0
Stroke	16.0	22.5	24.7	30.6	26.9	31.4
Emotional problems	10.5	14.4	13.5	18.0	13.7	15.6
Arthritis	11.5	17.3	14.4	19.0	12.6	17.0
Incontinence	13.6	17.5	17.0	21.9	37.2	22.3
Broken hip	15.6	21.0	13.4	20.3	9.9	41.7
Cataract surgery	9.0	13.5	12.9	18.9	13.5	18.8
Pain	13.6	18.6	17.6	23.5	15.1	21.0
Other problems	9.9	15.1	16.2	18.2	15.2	19.9

All multivariate analyses control for age cohort (birth years 1909–1913, 1914–1918, and 1919–1923 with pre-1909 births the reference group). Race is defined by the following categories: non-Hispanic African-American, Hispanic of any race, and white/other (including all who did not fall into the previous two categories).[7] Marital status is measured by a series of dummy variables indicating each of the following categories: currently married, living with a partner, never married, separated or divorced, and widowed. Educational attainment is defined by dummy variables indicating 12 or fewer years of education, some college, college degree, and advanced professional education (physicians, lawyers, Ph.D.'s).

Measurement of household resources (SES) is improved in three ways in this study. First, a broader concept of economic resources is employed by measuring both total household yearly income and wealth. Contemporaneous income may be a poor indicator of financial resources because income may drop with retirement even if wealth is at its lifetime peak. Similarly, racial and ethnic differences in wealth far outstrip racial and ethnic differences in income in this age group (Smith 1995, 1997).

Second, sources of income or wealth may be informative about the direction of influence between SES and health. For example, only healthy people are able to work, and some types of income are more often the consequence than the determinant of health conditions. Similarly, housing and nonhousing wealth have quite different degrees of liquidity in providing resources to alleviate current health problems. To test these ideas, we subdivide income and wealth into their major components.

Third, the literature is ambiguous on how SES affects health. One approach argues that the critical distinction is that of the poor from the nonpoor (see the discussion in Adler et al. 1993). The alternative view contends that the effect of economic resources persists throughout the entire range of SES in the population. The first approach implies that low-income status as an indicator of poverty is appropriate, whereas the second treats income as a continuous linear variable. To shed light on this question, we create two variants of income and wealth variables. The first involves a simple sum of total income and wealth (linear variant). In the second, we create a piecewise linear spline function, which permits estimation of different slopes over different ranges of the variable (nonlinear variant). The cut points for the slopes are determined by dividing the wealth and income distribution into terciles. Heuristically, we can think of these terciles

Conditional upon reporting any functional difficulty in any activity, we estimate the functional status score by OLS. Because there are no major statistically significant differences among the alternative models, we present only the Tobit estimates in the text.

[7] Sample sizes do not permit differentiation by Hispanic ethnic subgroups.

as dividing the population into the poor, the middle class, and the affluent.

The last set of covariates measures some salient dimensions of family background. One mechanism by which family background matters is through the intergenerational transmissions of health. These transmissions could reflect genetic endowments, the impact of parental resources during childhood and young adulthood, and the promotion of health behaviors across generations. Our measures include attributes of the parents (whether each had eight or more years of schooling, whether each is living, age at death), siblings (number of living brothers and sisters), and children. AHEAD data on respondents' children inform us about the numbers ever born and currently living, their gender, living arrangement (whether living with respondent), and marital status. While living arrangements of children are often used as a proxy for social support, the actual provision of such care is endogenous.

A primary interest in this research relates to uncovering any gender, racial, and ethnic differences in this health outcome. These demographic differences may appear not only through disparities in levels (main effects), but also through the manner in which other demographic and economic variables affect functioning (interaction effects). In all statistical models, we test explicitly for racial, ethnic, and gender interactions for all covariates. Only the statistically significant interactions are included in the final model.

The estimated coefficients and t statistics from our model predicting functional scores are presented in Table 2. Because chronic conditions may induce difficulty in functioning, this model is estimated with and without controls for specific chronic conditions. As the third column of Table 2 indicates, these chronic conditions, both individually and collectively, are strong predictors of the ability to function. The rank ordering associated with specific chronic conditions are as expected. Stroke, pain, and broken hips induce the worse level of functioning while hypertension, cataracts, and emotional problems are associated with the least functional impairment. A comparison of the two models in Table 2 indicates that including controls for specific chronic conditions mitigates, but does not eliminate, the impact of economic resources or family background.

Not surprisingly, the degree of difficulty in functioning rises sharply with age. This distinct age gradient characterizes all demographic groups and exists whether or not controls for specific chronic conditions are included in the model. A salient characteristic of frail old age is the cumulative deterioration in the ability to function in everyday activities, even when the presence of diseases are held constant. For example, compared to those respondents 85 years and older, our functional score is reduced by more than 10 points among those respondents in their early 70s.

In AHEAD, married respondents report fewer chronic conditions than respondents in other marital states. Once chronic conditions are controlled, however, functional limitations are actually highest among married couples. In addition to possible mortality selection effects, married couples may be less likely to alter their lives to accommodate their health problems. For example, they still may live in a large multi-floored home suitable to their childrearing years but not to their increasing frailty. In addition, having someone close by who can help may make married respondents more likely to answer that they need help to carry out daily activities.

Education may affect health through a number of channels. Schooling is an excellent measure of stable long-term economic status. More educated households may choose more qualified doctors, be more aware of the harmful health effects of behaviors such as smoking or environmental risks, or be better able to provide preventive self-care to prevent illness or to mitigate its more harmful effects.[8] There also exists a quite strong and ordered male pattern, with the largest reductions in the ability to function effectively occurring among college-educated males. Given the statistically significant interaction between having earned a college degree and gender, there is little evidence of any strong college effect for women. The earnings-generating impact of college may be more important for men, whereas the health information-gathering and -interpreting benefits of schooling may be associated with high school graduation for women—especially in these birth cohorts. Spousal schooling also promotes good health outcomes. In addition to the resource- and information-based interpretations assigned to the own education effect, spousal schooling may capture (in part) positive assortative mating in marriage markets as people in better health marry each other.

A primary goal of this research is to track the relationship between economic resources and health. Economic status has been found to be an important predictor of health outcomes among older adults (see Mare (1990) and Menchik (1993) for excellent examples using the longitudinal components of the 1966 NLS of Mature Men to analyze mortality). Table 2 contains tests on two central issues: the form of the relation and the relative importance of income and wealth.[9] Conclusions of health research are ambiguous about whether the SES association with health is largely a poverty-nonpoverty distinction or the association extends to all SES levels (Adler et al. 1993).

Our research indicates that both household income and wealth are correlated with higher health status, albeit in a highly nonlinear way. Although one cannot interpret the effects of income only as differentiating poverty-level families from those above the poverty line, the association is strongest within the lowest tercile and decays as one moves up either the income or the wealth distribution. For example, the estimated effect in the lowest income tercile is 166 times larger than the effect in the highest tercile. Misspecifying the

[8] Because its prior timing relative to current health makes it less subject to the confounding effects of reverse causation, many have argued that schooling is a preferred measure of SES. At a minimum, this argument is overstated due to the long-run evolution of both schooling and health status.

[9] Below we deal with the third issue: the different income and wealth components.

TABLE 2. NUMBER OF FUNCTIONAL LIMITATIONS (TWO-LIMIT TOBITS)

Variables	Coefficient	*t*	Coefficient	*t*
DEMOGRAPHIC				
White women	5.705	7.95	5.030	8.19
Black men	–1.614	1.01	–.451	0.33
Black women	3.187	2.54	5.364	5.03
Hispanic men	–3.045	1.39	–1.191	0.65
Hispanic women	2.538	1.43	2.810	1.90
BIRTH COHORT				
1919–1923	–11.718	12.98	–9.878	12.72
1914–1918	–7.956	8.91	–7.224	9.60
1909–1913	–5.113	5.63	–5.320	7.01
MARRIAGE				
Partner	–2.115	0.55	–3.547	1.06
Divorced or separated	–.404	0.21	–2.791	1.75
Widowed	–2.547	1.73	–2.483	2.02
Never married	1.879	0.62	–.532	0.21
EDUCATION				
12–15 years	–1.643	2.48	–.634	1.15
16 or more years	–5.029	3.23	–3.184	2.41
Professional degree	1.635	0.55	1.136	0.45
Spouse, 12–15 years	–2.163	2.26	–1.383	1.74
Spouse, 16 or more years	–0.693	0.48	–1.762	1.44
Spouse, professional degree	–8.851	1.98	–6.822	1.83
ECONOMIC RESOURCES[a]				
Income 1st tercile	–.516	3.58	–.411	3.42
Income 2nd tercile	–.355	4.05	–.230	3.14
Income 3rd tercile	.003	0.39	.001	0.10
Wealth 1st tercile	–.134	6.58	–.066	3.98
Wealth 2nd tercile	–.013	1.50	–.004	0.57
Wealth 3rd tercile	–.005	2.17	–.003	1.67
INTERACTIONS				
Race x Divorced or separated	–7.971	2.70	–3.411	1.38
Hispanic x Partner	15.381	1.48	19.810	2.32
Female x College	5.747	3.17	3.761	2.46
FAMILY BACKGROUND				
Number of living siblings	–.436	3.14	–.221	1.90
Number of spouse's living siblings	.026	0.13	–.048	0.29
Mother alive	–2.666	1.13	–.801	0.41
Mother's age at death	–.036	2.17	–.024	1.72
Father alive	–1.985	0.56	–5.322	1.80
Father's age at death	–.050	2.65	–.031	1.96
Spouse's parents' age at death	.026	1.28	.009	0.54
Mother's education > 7 years	.160	0.22	.488	0.80
Father's education > 7 years	–1.068	1.47	–1.305	2.16
Number of children born	.539	2.29	.147	0.75
Number of living children	–.325	1.18	–.108	0.47
HEALTH CONDITIONS				
Hypertension	—	—	.992	2.18
Diabetes	—	—	4.403	6.73
Cancer	—	—	2.871	4.52
Lung diseases	—	—	6.854	10.27
Heart condition	—	—	2.185	3.88
Heart attack	—	—	3.795	4.19
Angina	—	—	4.841	5.84
Stroke	—	—	11.712	17.03
Emotional problems	—	—	2.680	3.89
Arthritis	—	—	5.816	11.13
Broken hip	—	—	8.486	8.85
Incontinence	—	—	5.599	10.24
Cataract	—	—	1.212	2.44
Pain	—	—	10.954	22.01
Other health problems	—	—	5.199	10.91
Constant	60.437	2.28	46.776	2.16

(continued next column)

(Table 2 continued)

[a]Measured in thousands of dollars.

form of the income or wealth effect can lead to serious model misinterpretations. For example, if only linear variants of income and wealth are used, the magnitude of income and wealth effects on functioning appear much larger among black and Hispanic households. Because more black and Hispanic respondents are located in the bottom tier of economic

strata, where the effects are largest for all groups independent of race or ethnicity, an inference of racial differences in behavior would be incorrect. In the tercile form estimated in Table 2, we find no evidence that the effects of income or wealth vary by race, gender, or ethnicity.

In this age group, wealth is a salient dimension of economic status (see also Mare 1990; Menchik 1993). Moreover, in a linear specification, the impact of a dollar of wealth is about one-tenth of that of a dollar of household income. Because income is a flow and wealth a stock, the relative magnitude of these estimated effects are consistent with a 10% real interest rate. Appropriately dimensioned then, wealth has a quantitatively larger effect than household income on health status in the AHEAD sample. This may reflect shorter life spans and higher discount rates of older people.

Table 2 also includes measures of family background. Health status may be correlated across generations for many reasons: shared genetic endowments with some families intrinsically "healthier" than others, good health induced by parental economic resources, and common social and geographic environments (Preston and Elo 1992). AHEAD measures proxy the health of close relatives spanning three generations: parents (education and age of death), siblings (number of living siblings), and children (numbers ever born and currently alive). A parallel set of measures exists for spouses' relatives.

There is an emerging literature, most of which focuses on mortality and disease incidence, on the relation between early childhood events and health status in later life. Some researchers have posited a direct causal link between childhood and even fetal environment and adult morbidity and mortality (Barker 1990; Forsdahl 1978). Others have hypothesized that childhood SES acts primarily indirectly by influencing social or economic achievement in adulthood, which in turns affect adult health (Lynch, Kaplan, and Cohen 1994). Analysis of data on twins reared apart or together suggest that multiple mechanisms, involving adult and childhood SES, as well as genetic factors, may each contribute to the intergenerational correlation of health outcomes (Lichtenstein, Harris, and Pedersen 1993).

Our evidence suggests that intergenerational health transmission may be quite strong. Most parents of these elderly respondents are deceased, so parents' age at death may be a useful summary measure of parents' average lifetime health. AHEAD respondents are able to function better after age 70 if they still have a living parent; they also are able to function better the older their parents were when they died. The strength of this relation across generations is remarkable. Even though many AHEAD respondents have not lived with their parents for most of their adult lives, their health status after age 70 is strongly correlated with their parents' health (even after controlling for parents' and children's SES). The effect of parents' death age is quantitatively about the same for mothers' or fathers' death.[10] Supporting the notion that the underlying reasons may be either genetic or a proxy for economic and social resources during childhood, the ages a spouse's parents died has no impact on respondents' functional ability.[11]

Similar testimony to the role of family background appears with the same generation measure: the number of living siblings. This measure captures two effects: a (negative) indicator of resources available in the parental family and a marker of the health of these siblings through their survivorship. Given the age of our respondents, many of their siblings are also elderly and many others are already deceased. Because the parental resources effect implies a positive correlation with respondents' health and the sibling survivorship implies a negative correlation, our evidence indicates that the survivorship effect dominates. It is simply good news for one's own health and prospects of survival if he or she has long-lived brothers and sisters.

Finally, there are two measures of the respondent's children's generation included in our models: the number of children ever born and the number of living children. The dominant influence is through the number of children ever born, which has a negative impact on health. Given the number of births, however, the more children who survive into their parents' old age, the healthier the parents. This may be the mirror image of the parental correlation discussed above, as healthier children are a marker of healthier parents. Collectively, our evidence of significant intergenerational correlation in health indicates that some dimensions of health persist over long periods of individuals' life spans. This persistence has implications for the interpretation of the SES-health relation, a subject addressed in the next section.

MEASUREMENT OF HOUSEHOLD RESOURCES

Total household income is the conventional empirical proxy for aggregate economic resources in demographic research. It is frequently the only option available as demographic surveys typically expend little survey time measuring household resources in detail. If we place high priority on understanding why economic resources and health are interrelated, reliance only on total household income is unwise. Household income is built from subcomponents, many of which influence health or are affected by health in distinct ways.

To test this idea, we divide total household income into five conceptually distinct components: earnings, social security income, pensions, welfare income, and other income. We also distinguish between income received by the respondent and that received by a spouse. Welfare and other income are reported at the household level, but the other three income sources are reported separately for respondents and spouses.

[10] The other parents' characteristic—whether they had at least eight years of schooling—was statistically insignificant.

[11] Because there were no statistical significant differences between ages of death of spouses' mothers or fathers, the model summarized in Table 2 estimates an effect for spouses' parents age of death (e.g., the effect of mother's and father's age of death are constrained to be equal). While not included in Table 2 to conserve space, the model also includes a completely parallel set of variables for respondents' and spouses' parents, whether each parent is alive, and spouses' mother's and father's education. None of these spouse parents' variables are statistically significant.

Even with AHEAD's older sample of respondents, some individuals are still working, and any earnings from this work are part of household income. The primary income source in this age group, however, is derived from the major public and private sector retirement income programs: social security and private pensions. An important analytical advantage of retirement income at these ages is that it is relatively free of any contemporaneous feedback from current health to income. Although the formulas are quite different, both social security and pension income typically are determined by the entire sequence of lifetime earnings.[12] At these ages, an improvement or deterioration in current health typically will have no impact on the amount of current year retirement income. The fourth income component, placed under the generic label "welfare income," includes income from Supplementary Security Income (SSI) and food stamps. In contrast to the arguments just made about retirement income, the receipt of this income may well be a direct consequence of respondents' current health. Episodes of poor health and the low income associated with it may determine eligibility for these means-tested programs. The final income component—asset income—sums all income flows from annuities, IRA distributions, dividends and interest.

Table 3 summarizes estimated effects of different types of household income on the number of functional limitations. Coefficients of the other covariates included in the model but not listed in Table 3 are not altered significantly by the experiments we performed. We estimated the effects of eight separate income sources: earnings for each spouse,[13] social security and pension income for each spouse, welfare, and asset income.

The empirical estimates in Table 3 support differentiating among alternative sources of household income. For example, respondents' earnings are positively correlated with better health, whereas additional welfare income is associated with poorer functioning. As demonstrated below, for both these income sources, the primary causation flows from health to income as healthier individuals are more likely to work and less likely to receive welfare. Consequently, contemporaneous income flows from either earnings or welfare cannot be used to estimate income effects on health.

At least at these older ages, retirement income offers the best hope of estimating an income effect free at least of contemporaneous feedback effects from health to income. Virtually all AHEAD respondents are past the normal retirement age, so any contemporaneous reverse causation is impossible. Additional income through respondents' social security and, to a lesser extent, their pension, is correlated with improved functioning. For example, an extra $1,000 of social security income is associated with a half-point reduction in the functional score. Whereas this result implies that alterations in social security benefits could affect the functional ability of older people, the result should not be taken at face value.

Our argument is taken a step further in the third column of Table 3, which adds variables indicating zero-receipt of each income source. This model indicates that the effect of income is not continuous at 0 and that nonreceipt of many income sources is often what is informative about the SES-health correlation. In particular, only the indicators for the respondents' receipt of earnings or welfare are statistically significant; no statistically significant effects remain for variation in the amount of such income. The dominance of these income receipt dummy variables supports our interpretation of these effects as flowing from health to income. For example, the presence of earnings signals that health problems do not constrain a respondent's ability to work. Similarly, the receipt of any welfare income is associated with lower current health status, a causation more readily interpreted as running from health to income. Further, Table 3 indicates that the existence of a respondent's pension, not the size of the annuity from that pension, is correlated with functional ability. Because individuals who have or do not have pensions are different in many unobserved ways—including their long-run health status—variation among respondents in pensions is not the key to estimating income effects on health.

In contrast to pensions, social security is an almost universal program, so selectivity of participation is not a relevant issue. Variation in social security benefits then would appear to offer the best hope of isolating income effects. We still estimate reasonably sized income effects from respondents' social security benefits in Table 3, even after controlling for whether any social security income is received. The absence, however, of any effects of spousal social security income on respondents' functional limitations in Table 3 raises a serious warning flag.

If income is shared among spouses, spousal income actually may be the preferred candidate for estimating income effects on health. While arguably free of contemporaneous feedbacks from health to income, long-run feedbacks from past respondent health to current respondent social security (or pension) benefits are still possible. Respondents in poor health in the past worked fewer hours, possibly at a lower wage, so their lifetime earnings stream (and hence their social security and pension annuities) will be lower. Given the persistence of health conditions over long periods (as evidenced by the generational correlations above), these long-run feedbacks from respondent health to respondent social security income cannot be dismissed easily.

As long as assortative mating by health status is imperfect, any past health feedbacks to current benefits will be much muted in spousal income.[14] Table 3 indicates, however, that the association of spousal social security with respondent functioning is essentially 0. The combined respondent and spouse social security effects estimated in Table 3 are

[12] For example, a social security benefit is based on a worker's average indexed covered earnings (AIME) computed over the number of covered years.

[13] Current market earnings is the sum of wages and salary, bonuses, overtime, tips, commissions, and self-employment income from all jobs.

[14] Positive assortative mating in the health of spouses will lead to the same types of feedbacks discussed for the respondent.

TABLE 3. EFFECTS OF ALTERNATIVE SOURCES OF INCOME AND WEALTH ON THE NUMBER OF FUNCTIONAL LIMITATIONS

	Coefficient	*t*	Coefficient	*t*
EARNINGS[a]				
Respondent	−.1187	2.78	.0583	1.34
Spouse	.0466	1.09	.0256	0.52
SOCIAL SECURITY INCOME				
Respondent	−.5696	5.88	−.3943	3.69
Spouse	.0186	1.48	.1077	0.74
PENSION INCOME				
Respondent	−.0782	1.64	−.0032	0.06
Spouse	−.0478	0.72	−.0204	0.26
Welfare	.9461	3.19	−.4253	1.07
Asset	.0005	0.05	.0032	0.35
ASSETS				
Housing	−.0154	4.25	−.0129	3.61
Nonhousing	−.0091	4.38	−.0077	3.72
EARNINGS = 0				
Respondent	—	—	9.7734	8.85
Spouse	—	—	−1.3844	1.03
SOCIAL SECURITY = 0				
Respondent	—	—	1.0460	0.65
Spouse	—	—	−2.0066	1.11
PENSION INCOME = 0				
Respondent	—	—	1.6571	2.47
Spouse	—	—	0.2414	0.24
Welfare = 0	—	—	−6.2366	4.82
Asset = 0	—	—	3.3754	5.53

[a]All continuous income and assets measured in thousands of dollars.

consistent with no income effects on health in this age group, but significant long-run feedbacks from past health to past and current income.[15]

When long-term feedbacks from health to income exist, the causal problem is not resolved simply by using panel data with long-term measures of economic status, such as wealth, prior period income, or permanent income (Mare 1990; Menchik 1993).[16] These income measures, often available in longitudinal but not cross-sectional data, are still contaminated by any long-term feedbacks from health to income. Instead it is necessary to employ statistical identification methods that isolate income variation unrelated to health and health outcome variation unrelated to income. In this paper, we suggest one possibility in a cross-section survey: spouse's social security benefits (still with the caveat on assortative mating).

Table 3 also demonstrates that our two major components of wealth—housing and nonhousing—are positively correlated with better functioning. Because nonhousing wealth is more liquid and presumably more readily available to alleviate health problems, we anticipate that the impact of nonhousing wealth would be quantitatively larger. We cannot reject, however, the hypothesis that the estimated impacts of housing and nonhousing wealth are the same. The relative importance of wealth in influencing health outcomes in old age should not be viewed as evidence that wealth causes health. Just as the correlation between some income components and health in old age reflect feedbacks from health to income, over a longer horizon the ability to accumulate wealth is affected by past health. A deterioration in health may reduce a household's ability to save, which eventually will show up as lower wealth levels in old age.

DEMOGRAPHIC DISPARITIES IN HEALTH OUTCOMES

Do the demographic and economic differences that exist among them explain functional health disparities by gender, race, and ethnicity? To answer this question, we obtain adjusted functional status scores by the following procedure. First we estimate white male functional scores based on the actual white male sample characteristics. For all other demographic groups, we calculate predicted scores by randomly selecting a white male to "substitute" his attributes for the observed characteristics of each woman or minority group member. We then reestimate scores for each newly created observation with these newly acquired attributes, but use the coefficients estimated within the individual's original gender, racial, or ethnic group. This procedure standardizes female, African-American, and Hispanic sample scores based on the economic and demographic attributes of the white male sample.

The first row in Table 4 lists the original model prediction for each demographic group, and the following two rows contain simulated predictions obtained by substituting white male attributes. The second row in Table 4 contains the predictions obtained from the model listed in Table 2, and the third row lists predictions derived from an augmented model that includes a standard set of health "risk factors."[17] We

[15] Social Security is not the ideal variable to test this hypothesis because so many spouses receive a spousal benefit (50% of their spouse's benefit) rather than a benefit based on their own past earnings. If this were all there was, however, the effect of spousal Social Security would be the same as that of the respondent. Table 3 indicates that this is certainly not the case.

[16] Menchik also includes measures of initial period self-reported health status (excellent, very good, good, fair, poor) in his models. This does not resolve the problem because as Smith (forthcoming) demonstrates, there exists considerable variation in health (including functioning) within these categories.

[17] AHEAD includes an important subset of self-reported risk factors: current and past smoking, current drinking, past drinking problem, and height and weight (translated into a BMI index (height [in cm]/weight [in

TABLE 4. PREDICTED STANDARDIZED FUNCTIONAL SCORES

	White Men	White Women	Black Men	Black Women	Hispanic Men	Hispanic Women
Unadjusted	6.570	11.489	9.789	14.379	10.012	14.381
Basic Model	6.570	9.571	6.481	9.564	5.945	7.968
Risk Factors	6.570	9.592	6.169	9.322	5.764	8.013

reach two conclusions from Table 4: (1) the covariates in the model, including those that proxy the household's SES, can explain racial and ethnic disparities in functioning, but (2) there remain significant unexplained gender differences in functioning.[18]

The almost 50% larger Hispanic and black male levels of functional limitation are eliminated, largely due to our extensive controls for their different SES compared to white men. This result implies that the greater inability of minority groups to function effectively during old age has little to due with race or ethnicity per se. Our models indicate, however, that the joint interaction of SES and health plays a much greater role in explaining racial and ethnic differences in the ability to function than in explaining who has specific chronic illnesses. In results not shown here due to space constraints, our full set of covariates, including our SES measures, account for only a small part of baseline differences in the prevalence of chronic conditions across racial, ethnic, or gender groups. Indeed, it is only a slight oversimplification to claim that the SES-health interaction (whatever its causal pathway) explains all of the racial and ethnic disparities in ability to function, but only moderate amounts of any baseline differences in disease prevalence.

What pathways could account for the quite distinct association of SES with racial and ethnic differences in these two different dimensions of health? The onset and persistence of chronic conditions reflects the cumulative impact of past behaviors, risks, and constraints. Consequently, measurement of current resources available to the household—this year's income and even current wealth—may not adequately capture lifetime resource constraints that led to and are affected by illness in middle age. It may require observations on populations over long periods of time to isolate any mutual interaction of SES with the prevalence of chronic conditions.

Our finding of weaker SES effects on the prevalence of chronic conditions is unlikely to be explained fully by refinements in measurement. It would not explain, for example, the much higher black prevalence for hypertension compared to Hispanics because both groups have quite similar levels of current and past economic resources. In addition to possible genetic differences, a topic on which there exists substantial controversy, race and ethnic differences in diet and the macroenvironment may be a promising area to explore. Stress may well intensify when people live in crowded low income neighborhoods, frequently characterized by high rates of victimization through crime and drugs and offering little reason for hope. Because African-Americans and Hispanics are more likely to live in such environments, variation across groups in their macroenvironments may intensify individual-level differences in SES.

While race and ethnic disparities in functioning are explained in our models, there remains a large and statistically significant gender difference. Our adjusted predictions show that compared to men, women of each racial and ethnic group have more functional limitations. Several mechanisms have been proposed to explain such gender differences (Verbrugge 1989). Biological differences by sex, most notably hormonal differences and factors related to reproduction, may indicate that the cumulative impact of maternal depletion persists into old age. For example, Kington and colleagues found a relationship between parity and general health among women over age 50 (Kington, Lillard, and Rogowski 1997). Other explanations involve differences between men and women in how they perceive and report symptoms and health outcomes. This hypothesis is best captured in the stereotype of the stoic man, reluctant to tell others about his health problems. More frequent contact by women with the health care system, primarily related to reproduction, may lead to greater awareness of health issues and a greater likelihood of reporting health problems. Finally, differential mortality by sex may play a role. Men in very poor health die at younger ages, so only the more robust men survive to older ages.

CONCLUSION

In this paper we address some basic questions about the relationship between economic resources and health outcomes. Our results imply that, while often used in applied research, current period household income aggregates are not a reliable empirical construct on which to base predictions about the effects of additional economic resources on current health. The reason is that these income components are con-

kg])). These measures are available for the respondent and spouse. Including these risk factors does not alter any of the conclusions in the two previous sections.

[18] While risk factors were statistically important, their collective impact on gender, racial, or ethnic health disparities is relatively modest. The gender disparity in health outcomes is actually slightly larger when risk factors are included in the model. Compared to men, women engage in fewer risky activities, particularly revealed in reported past smoking and problem drinking.

taminated either by within-period or long-run feedbacks from health to income. Such feedbacks represent serious analytical issues that cannot be ignored if we want to understand the meaning of the SES-health nexus. At a minimum, our research suggests that components of household income and who receives it should be distinguished both in the collection and in the analyses of demographic data. Because of the dual interaction between health and SES, demographic surveys and research must also be designed to provide variables capable of identifying each direction of influence. For example, labor market demand shocks may be an example of the income variation unrelated to health; price variation across health plan options may isolate health variation unrelated to income. The advantage of longitudinal over cross-sectional data for solving this problem is that panel data offer more opportunities for isolating such independent variation. The panel dimensions of surveys such as AHEAD will be quite useful for such research.

This research also demonstrates that health outcomes at old age are influenced by health attributes of past, concurrent, and future generations of relatives. In particular, the AHEAD respondents' parents' age of death and number of surviving siblings are both correlated with disease prevalence and the ability of the elderly to function. Whether this correlation reflects shared genetic endowments—where some families are healthier than others—or the cumulative impact of common social, economic, and geographic environments remains an important unanswered research question.

The strength of the correlation implies, however, that there exists significant temporal persistence in health from early childhood to very old age. Because early health outcomes can affect subsequent decisions such as schooling, marriage, fertility, and earnings, in general it would be inappropriate simply to use these demographic variables to explain variation among individuals in their current health. Instead, it is necessary to explicitly model these feedback mechanisms and to isolate within-period innovations in the stock of health. Such a research agenda is easier said than done, but progress on understanding the critically important relation between SES and health requires it.

APPENDIX TABLE A2. ACTIVITIES ASSESSED IN FUNCTIONAL STATUS INDEX

How difficult is it for you to...

1. walk across a room?
2. dress, including putting on shoes and socks?
3. bathe or shower?
4. eat?
5. get in and out of bed?
6. use a toilet?
7. walk several blocks?
8. climb a flight of stairs?
9. pull or push large objects like a living room chair?
10. lift or carry weights over 10 pounds, like a heavy bag of groceries?
11. pick up a dime from a table?

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