Unraveling the SES–Health Connection

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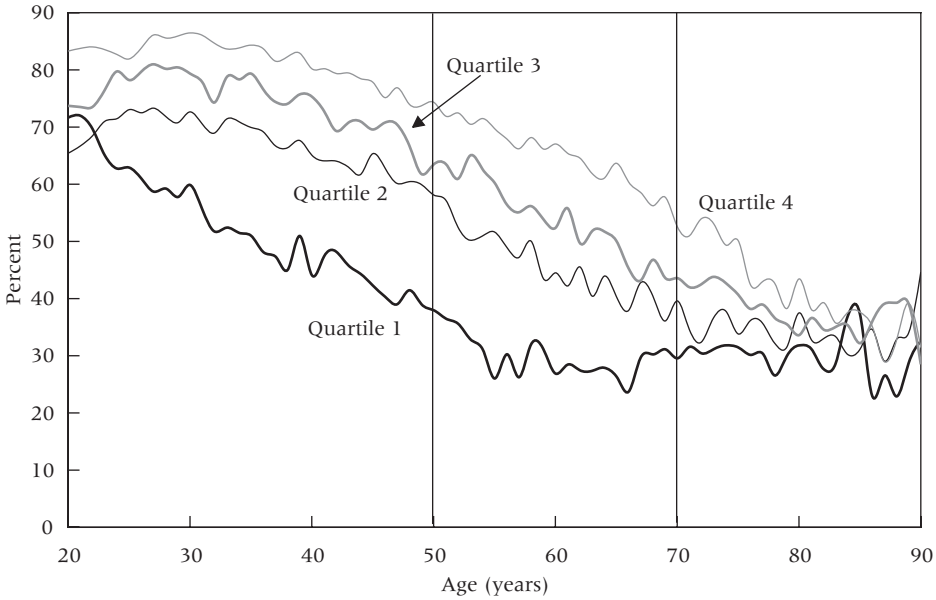
People of lower socioeconomic status (SES) consistently appear to have much worse health outcomes.[1] No matter which measures of SES are used or how health is measured, the evidence that this association is large and pervasive across time and space is abundant (Marmot 1999; Smith 1999). To document its principal features, Figure 1 displays the main contours of the socioeconomic status health gradient in the United States by plotting at each age the fraction of people who self-report themselves in excellent or very good health by age-specific household income quartiles. Figure 2 plots the same fractions for people in poor or fair health.

Until the end of life, at each age every downward movement in income is associated with being in poorer health. Moreover, these health differences by income class can only be described as dramatically large. The fraction in excellent or very good health in the top income quartile is often 40 percentage points larger than the fraction in the lowest income quartile. In both Figures 1 and 2, there also exists a strong nonlinearity in the relation between income and health, with the largest health differences taking place between the lowest income quartile and all the others. Since this nonlinearity will prove to be important in resolving some of the key issues surrounding the SES health gradient, I return to it below. Finally, there is a distinct age pattern to the SES health gradient, with health disparities by income class expanding up to around age 50 years, after which the health gradient slowly fades away.[2] This age pattern will also be critical later in this chapter.

There is a broad consensus about the facts and about the key scientific and policy questions surrounding the SES health gradient—only the answers are controversial. Do these large differences in health by socioeconomic status indicators such as income largely reflect causation from SES to health, as many noneconomists appear to believe? Medical scientists are often convinced that the dominant situation is that variation in socioeconomic status produces large health disparities; their main debate is about why low economic status leads to poor health (Marmot 1999). Recent and often insight-

FIGURE 1 Percent reporting excellent or very good health status by age-specific household income quartiles



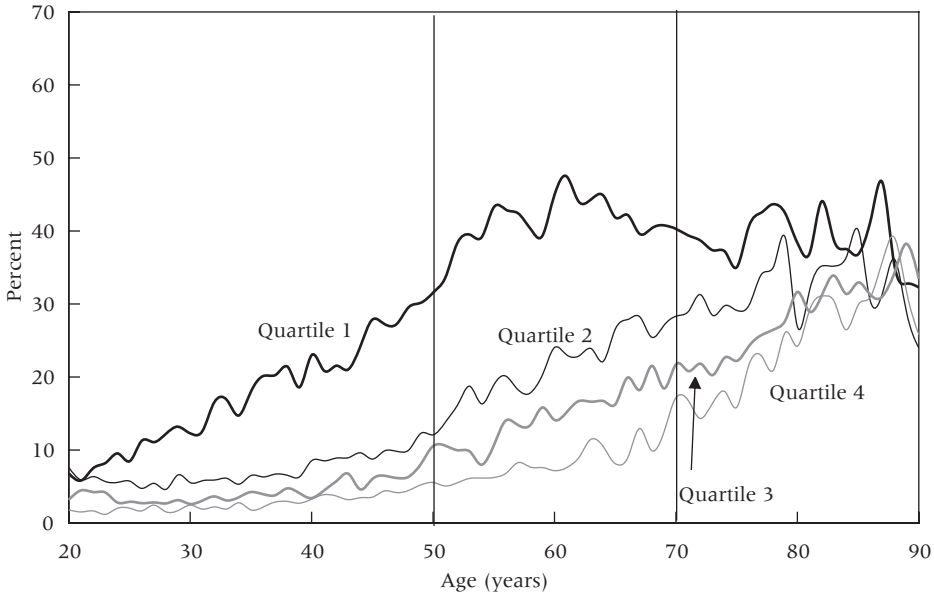
SOURCE: Calculations by author from the pooled National Health Interview Surveys 1991–96.

ful contributions by these scholars have investigated the influence of other factors besides access to high-quality health care or deleterious personal behaviors, both of which are believed to offer incomplete explanations. These contributions have instead emphasized long-term impacts of early childhood or even intrauterine environmental factors (Barker 1997), the cumulative effects of prolonged exposures to individual stressful events (Seeman et al. 1997), or reactions to macro-societal factors such as rising levels of income inequality (Wilkinson 1996) and discrimination (Krieger 1999).

While debate continues about competing reasons why SES may affect health, there is little recognition that the so-called reverse causation from health to economic status may be fundamental as well. Even if the direction of causation is that SES mainly affects health, what dimensions of SES actually matter: the financial aspects such as income or wealth, or nonfinancial dimensions like education? Finally, is there a life course component to the health gradient so that we may be misled in trying to answer these questions by looking only at people of a certain age—say those past 50?

This chapter, which is divided into four sections, provides my answers to these questions. The first section examines the issue of reverse causation or whether a new health event has a significant impact on four aspects of SES: out-of-pocket medical expenses, labor supply, household income, and household wealth. The next section switches the perspective by asking

FIGURE 2 Percent reporting fair or poor health status by age-specific household income quartiles



SOURCE: Calculations by author from the pooled National Health Interview Surveys 1991–96.

whether the so-called direct causation from SES to health really matters. Because the answer is yes, a subtheme in this section concerns which dimensions of SES—income, wealth, or education—matter for individual health. The answer to that question turns out to be education, and the third section deals with the much more difficult issue of why education matters so much. The evidence in these first three sections relies on data for people above age 50. Figures 1 and 2 suggest that the nature of the SES health gradient may be quite different after age 50 than before. In the final section I test the robustness of my answers to these basic questions about the meaning of the SES health gradient, using data that span the entire lifecourse.

Does health affect socioeconomic status?

The primary focus among epidemiologists and those in the health research community more generally has been on disentangling the multiple ways in which socioeconomic status may influence health outcomes. Consequently, much less is known about the possible impacts health may have on SES. But for many individuals, especially those who are middle aged, health feedbacks to labor supply, household income, or wealth may be quantitatively important. I explore this question by estimating the effect of new health events on subsequent outcomes that are both directly and indirectly related

to SES. The outcomes investigated include out-of-pocket medical expenses, labor supply, household income, and wealth.

Before summarizing those results, I first outline the essential issues in estimating the effects of SES on health as well as the effects of health on SES. Current economic status and health reflect a dynamic history in which health (H_t) and SES (Y_t) are mutually affected by each other as well as by other relevant forces. Most of the relevant ideas can be summarized by the following two equations:

$$H_t = \alpha_0 + \alpha_1 H_{t-1} + \alpha_2 Y_{t-1} + \alpha_3 \Delta\hat{Y}_t + \alpha_4 X_{t-1} + u_{1t} \quad (1)$$

$$Y_t = \beta_0 + \beta_1 H_{t-1} + \beta_2 Y_{t-1} + \beta_3 \Delta\hat{H}_t + \beta_4 X_{t-1} + u_{2t} \quad (2)$$

where X_{t-1} represents a vector of other possibly nonoverlapping time- and non–time-varying factors influencing health and SES, and u_{1t} and u_{2t} are possibly correlated shocks to health and SES. The key parameters α_3 and β_3 measure the effects of new innovations of SES ($\Delta\hat{Y}_t$) on health and health on SES ($\Delta\hat{H}_t$) respectively. In this framework, we can also estimate whether past values of SES predict health ($\alpha_2 \neq 0$) or past values of health predict SES ($\beta_1 \neq 0$).[3]

While cross-sectional data can shed light on these issues, there are advantages to examining questions of causation with panel data. To estimate the "effect" of either (α_3 or β_3) on the other, we require exogenous variation in health (or SES) that is not induced by SES (health). In particular, this implies that it is not appropriate to use the complete between-period changes in health or SES to estimate these effects since such variation hopelessly confounds feedback effects.

In an earlier paper (Smith 1999), I proposed a research strategy for isolating new health events: the onset of new chronic conditions. While to some extent people may anticipate onset, much of the actual realization and especially its timing may be unanticipated. While new onsets may provide the best chance of isolating health shocks, not all new onset is a surprise. A set of behavioral risk factors and prior health or economic conditions may make some people more susceptible than others to this risk. Thus, predictors of new onsets should be included in models so as to increase one's confidence that the remaining statistical variation in new onsets is "news." I make a similar point in the next section in discussing the impact of SES on health.

A new health event in one year may affect medical expenditure, labor supply, and income not only in that year but in future years as well. For example, the onset of a new condition may induce only single-period changes in labor supply, after which labor supply may stabilize. But spillover effects of a health shock may further depress work effort in future years, or

alternatively some recovery to original levels may take place. One way of estimating such patterns is to estimate a series of four equations for each of waves 2 through 5 of the Health and Retirement Study, summarizing changes in each outcome between adjacent waves (say labor supply L_t) as

$$\Delta L_t = \alpha X + \sum_{t-2}^{5} \beta_t \Delta H_t$$

where L_t is the between-wave change in labor supply and H_t the within-period health event from period t to t–1. Similar equations would apply for household income, out-of-pocket medical expenses, and other outcomes. If there is only a contemporaneous one-period effect of health events, all lagged values of changes in health will be zero.

The research I summarize here uses the first five waves of data on health status and transitions, medical expenses, labor supply, income, and wealth accumulation from the Health and Retirement Study (HRS). HRS is a national sample of about 7,600 American households (12,654 individuals) with at least one person in the household aged 51–61 years originally interviewed in the fall of 1992 and winter of 1993. The principal objective of HRS is to monitor economic transitions in work, income, and wealth, as well as changes in many dimensions of health status. Follow-ups of HRS respondents were fielded at two-year intervals. HRS instruments span the range of behaviors of interest: on the economic side, work, income, and wealth; on the functional side, health and functional status, disability, and medical expenditures.

In addition to its excellent array of economic variables, HRS measured many aspects of respondents' health. These included self-reports of general health status, the prevalence and incidence of many chronic conditions, the extent of functional limitations, and out-of-pocket and total health care expenditures. The chronic diseases asked about include hypertension, diabetes, cancer, chronic lung disease, heart problems (e.g., heart attack, angina, coronary heart disease, congestive heart failure), stroke, and arthritis. In addition, risk behaviors include current and past smoking, current and past drinking, self-reported height and weight (BMI), and exercise.

To calculate the impact of the onset of new health events, I estimated a parallel set of models predicting out-of-pocket medical expenses, changes in labor supply, and changes in household income. A vector of baseline attributes is included in all models, including baseline measures of birth cohort (or age), marital status, race, ethnicity, education, region of residence, quintiles of family income, and most importantly an extensive vector of measures of baseline health. These health measures include dummies for four of the five categories of self-reported health status, the presence at baseline of each chronic condition, a set of behavioral risk factors (smok-

ing, exercise, BMI, drinking), and a scaled index of functional limitations based on the answers to the questions about activities of daily living.

I divided new health shocks into two categories—major (cancer, heart disease, and diseases of the lung) and minor (all the rest). My results for health shocks that took place between the first and second wave of HRS are summarized in Table 1.[4] The columns represent the principal outcomes of interest (medical expenses, labor supply, and household income) while the rows trace the evolving impact of this health shock across the HRS waves. The final row summarizes the full impact of the health event across all five waves.

A severe health shock that occurred between waves 1 and 2 of HRS initially increased mean out-of-pocket medical expenses by $1,720 during the two-year interval in which it happened. This same health event also produced future increases in health costs that were of progressively smaller amounts. By the fifth wave, the mean total cost was a little over $4,000 so that less than half of the incremental costs were borne around the time of the event. All of these impacts on out-of-pocket medical expenses were much smaller when the health event was minor.[5]

Similar to the time pattern of effects documented for out-of-pocket medical expenses, the onset of a new severe health shock has the immediate and large impact of reducing the probability of working, followed by diminishing ripple-like effects in subsequent waves. To illustrate, a severe health event between the first and second wave of HRS reduced the probability of work by 15 percentage points between the two waves. Since the average labor force participation rate at baseline among those who were

TABLE 1 Impacts during waves 2–5 of a new health shock occurring between waves 1 and 2

Wave	Out-of-pocket medical expenses ($)	Work probability	Household income ($)
Major health shock			
2	1,720	–.148	–4,033
3	1,037	–.054	–1,258
4	893	–.030	–658
5	503	–.036	–269
Total	4,153	–.268	–6,258
Minor health shock			
2	175	–.041	–498
3	313	–.036	–988
4	160	–.017	–44
5	567	–.013	–169
Total	1,215	–.107	–1,699

SOURCE: Calculations by author from first five waves of the US Health and Retirement Study.

about to experience this major health event was .55, the impact on work is decidedly not trivial. Once again, estimated incremental effects in subsequent years cascade downward so that by the end of HRS wave 5, the probability of work had declined by about 27 percentage points as a result of a major health shock between waves 1 and 2. Just as was reported for medical costs, estimated effects are considerably smaller if the health events come under the minor label.

Not surprisingly, given the labor force results just described, new health events also depress household income, with the reduction larger when the shock is major. There is no evidence of household income recovery in subsequent years, so that the initial income losses persist. In fact, consistent with the labor force participation effects, additional diminishing income losses occur in subsequent waves. The final row in Table 1 presents the total household income loss associated with the health event. On average, by the end of wave 5 total household income is about $6,300 lower when a major health event was experienced between the first and second waves of HRS. The comparable estimate for a minor health event was about $1,700.

Income losses that persist over time can eventually accumulate into large sums indeed. The first rows in Table 2 (for major health events) and Table 3 (for minor health events) contain my estimates of the cumulative income loss associated with the onset of health events occurring between the HRS waves. To illustrate, by wave 5 a health event that took place between the first two waves of HRS led to a total loss in household income of almost $37,000. These losses in household income are typically far larger than any cumulative out-of-pocket medical expenses associated with the health event. For example, for the wave 1–2 major health shock, the out-of-pocket medical expenses of about $4,000 are only one-ninth of the total household income loss. While lower for the severe health shocks that took place between the other waves of HRS, cumulative income losses typically

TABLE 2 Cumulative impact of a new major health event taking place between

	W1–W2 ($)	W2–W3 ($)	W3–W4 ($)	W4–W5 ($)
HRS sample				
Cumulative income loss	–36,884	–13,828	–6,856	–3,601
Cumulative income loss + out-of-pocket expenses + lost interest	–48,941	–19,388	–9,805	–5,901
AHEAD sample				
Cumulative income loss + out-of-pocket expenses + lost interest	–11,347	–3,553	–3,005	

SOURCE: Calculations by author from first five waves of the US Health and Retirement Study and the first four waves of US AHEAD Survey.

TABLE 3 Cumulative impact of new minor health event taking place between

	W1–W2 ($)	W2–W3 ($)	W3–W4 ($)	W4–W5 ($)
HRS sample				
Cumulative income loss	–8,727	–8,811	–6,949	351
Cumulative income loss + increased expenses + lost interest	–11,544	–11,584	–8,610	–316
AHEAD sample				
Cumulative income loss + increased expenses + lost interest		5,926	–6,838	–702

SOURCE: Calculations by author from first five waves of the US Health and Retirement Study and the first four waves of US AHEAD Survey.

exceed cumulative medical expenses by a large single-digit integer. Once again, cumulative household income losses are much smaller when the health event is minor, but even in this case income losses far exceed the additional medical expenses.

Table 2 also includes the same summary measures of household income loss and cumulative medical expenses obtained from the same models estimated using the original AHEAD sample, a sample of respondents who were at least age 70 at baseline. Given the predominance of retirement and virtually universal coverage by Medicare in the AHEAD sample, not surprisingly changes in household income and out-of-pocket medical expenses triggered by a new health event, whether major or minor, are considerably smaller. There is much less possibility of income loss since most AHEAD respondents' income is annutized either through Social Security or through private pensions and thus is not contingent on changes in health status (Smith and Kington 1997). These much smaller feedbacks from health to several SES measures in AHEAD serve as a warning that the magnitude of any causal effects from health to SES may vary a good deal over the life course. I return to this issue in the penultimate section.

The lifetime budget constraint linking consumption, income, wealth, and savings implies that this sum of period-by-period income loss plus medical expenses (adjusted by the forgone interest on this money) represents one way of measuring the wealth change or dis-savings that took place across the first five waves of HRS owing to the health shocks.[6] This measure of lost wealth is listed in the second rows of Tables 2 and 3. My estimates of the reduction in wealth due to a new health event are not trivial—for a new major health shock between the first and second HRS wave it is almost $50,000. Given the much smaller income losses involved, estimated wealth losses are considerably smaller when the health events are minor and when estimated for the older AHEAD sample.

These numbers in Tables 2 and 3 can be used to illustrate the macroeconomic losses due to new bad health events. In the HRS sample (those ages 51–61 at baseline), about one-fifth of respondents experienced a major health event during the next eight years and another 30 percent had a minor health event. Since there were approximately 35 million Americans in that age range, this implies that about 7 million persons will have a serious onset and 10.5 million a minor onset. The total costs in the household sector alone of the serious onsets that took place within the eight-year window would be 350 billion dollars. Since the total costs of the minor onsets would be 121 billion, the combined economic costs of these health events are a little less than 500 billion dollars. While these numbers are only illustrative, they do suggest that the economic benefits from better health among those in their 50s can translate into very large numbers, even when only the narrow dollar metric of economics is used. Moreover, these aggregate economic costs associated with new onsets of bad health will likely grow rapidly in the future as the numbers of Americans at risk for these health onsets expands with the aging of the baby boom generations.

What then have we learned? First, at least among people in their 50s, pathways from health to the financial measures of socioeconomic status are decidedly not trivial. Especially as time unfolds, new health events have a quantitatively large impact on work, income, and wealth. This pathway should not be viewed as a sideshow to the main event. Second, the principal risk people face when poor health arrives is not the medical expenses they must pay but rather the currently not fully insured loss of work and income. Finally, not all health events are alike. My estimates have produced quantitatively different effects of the health events labeled major compared to those that are minor ones.

Does socioeconomic status affect health?

Finding evidence of significant feedbacks from new health events to several key measures of socioeconomic status does not negate the likelihood that the probability of experiencing the onset of a new health event is not uniform across several SES dimensions. I explore the pathway from SES to health by examining whether the onset of new chronic conditions is related to levels of household income, wealth, and education, once one specifies a set of preexisting demographic and health conditions.[7] I also explore the extent to which innovation in economic status "causes" health.

These models again include as covariates a vector of baseline health conditions of the respondent: self-reported general health status, the presence of a chronic condition at baseline, and the extent of functional limitations scale. The models also include a standard set of behavioral risk factors (currently a smoker, number of cigarettes smoked), whether one engages in vigorous ex-

ercise, body mass index, and a standard set of demographic controls: birth cohort, race, ethnicity, sex, and region of residence. My main interest, however, lies in the SES measures that include household income, baseline levels of and changes in household wealth, and respondent's education.[8] Strictly speaking, the ability of past histories of income and wealth to predict future health onsets does not imply causality since there may remain observed factors correlated with these past histories of household financial resources and with health trajectories. However, it is likely that most of these unobserved factors are positively correlated both with higher financial resources and with better health so that the absence of any predictive effects of SES on health is very informative.

Just as one needed innovations in health that were not caused by SES to estimate the impact of health on SES, so it is necessary to isolate innovations in SES that were not caused by health to estimate the impact of SES on health. One opportunity for doing so lies in the large wealth increases that were accumulated during the stock market surge in the United States during the 1990s. Given the unusually large gains in the stock market during these years, it is reasonable to posit that a good deal of this surge was unanticipated and thus captures unanticipated exogenous wealth increases that were not caused by a person's health. If financial measures of SES do improve health, such increases in stock market wealth should be associated with better subsequent health outcomes, at least with a lag.[9]

Knowing which aspect of SES affects health is key to the policy debate that surrounds the issue of the SES health gradient. For example, consider the extreme where all pathways from SES to health operate through education and none through the primary financial measures of SES, namely income or wealth. If that were so, then policies directed at income redistribution, while perhaps desirable on their own terms, could not be justified in terms of any beneficial impact on health. Combining all dimensions of SES into a single construct basically precludes discussion of most of the policy-relevant options.[10]

The results from these models, reported in Table 4, are provided for onsets of major and minor conditions and for each chronic disease separately. A consistent generalization can be made for household income—it never predicts future onsets of either minor or major health conditions. In no single case is the estimated coefficient on household income (which vacillates in sign) statistically significant. While the coefficients on wealth lean toward negative values (5 out of 7), in only one case (stroke) is a statistically significant negative result obtained for household wealth. Finally, my best measure of an exogenous wealth change—the wealth increase from the stock market—is statistically significant in only one instance (arthritis), and there it has the incorrect sign so that an increase in stock market wealth makes the onset of arthritis more likely. In sum then, SES variables that

TABLE 4 Probits predicting the future onset of specific chronic conditions

	Any major condition		Any minor condition	
SES indicator	**Estimate**	**Chi square**	**Estimate**	**Chi square**
Income	0.0111	0.06	–0.0063	0.03
Wealth	–0.0046	2.26	–0.0005	0.05
12–15 years schooling	–0.1108	7.78	–0.0912	5.96
College or more	–0.0844	2.43	–0.1588	10.26
Change in stock wealth	–0.0004	0.44	0.0004	0.88
	Cancer		**Hypertension**	
	Estimate	**Chi square**	**Estimate**	**Chi square**
Income	0.0130	0.05	0.0153	0.11
Wealth	–0.0030	0.53	–0.0032	1.01
12–15 years schooling	0.0008	0.00	–0.0675	2.45
College or more	0.0567	0.61	–0.0623	1.17
Change in stock wealth	0.0003	0.32	–0.0001	0.11
	Diseases of the lung		**Diabetes**	
	Estimate	**Chi square**	**Estimate**	**Chi square**
Income	–0.0271	0.12	0.0382	0.40
Wealth	–0.0067	1.13	–0.0023	0.29
12–15 years schooling	–0.1920	10.32	–0.1153	4.82
College or more	–0.1432	2.67	–0.0777	1.11
Change in stock wealth	0.0006	1.13	–0.0023	1.37
	Heart disease		**Arthritis**	
	Estimate	**Chi square**	**Estimate**	**Chi square**
Income	–0.0447	0.64	–0.0069	0.03
Wealth	0.0015	0.19	0.0000	0.00
12–15 years schooling	–0.1086	5.10	–0.0819	4.29
College or more	–0.0519	0.62	–0.1857	12.14
Change in stock wealth	–0.0012	1.36	0.0006	2.41
	Stroke			
	Estimate	**Chi square**		
Income	0.0683	0.70		
Wealth	–0.0175	3.83		
12–15 years schooling	–0.0390	0.36		
College or more	–0.0746	0.59		
Change in stock wealth	–0.0017	0.57		

NOTE: Models also control for presence of baseline health (self-reported health status, functional limitations, and the existence of specific chronic conditions) and a standard set of health risk factors (smoking, drinking, and BMI). In addition, sex, race, ethnicity, and region of residence are included. Income and wealth measured in $100,000 of dollars.
SOURCE: Calculations by author from first five waves of the US Health and Retirement Study.

directly measure or proxy for family's financial resources are either not related or at best only weakly related to the future onset of disease over the time span of eight years.

This largely negative conclusion is in sharp contrast to the results obtained for the final SES measure, education. Additional schooling is strongly and statistically significantly predictive of the new onset of both major and minor disease over the first five waves of the HRS. In all cases except cancer (which looks like an equal opportunity disease), the effects of schooling are preventative against disease onset.

This moves us to the most perplexing question of all: why does education matter so much in the promotion of good health? To provide insight on this question, I ran expanded versions of these models that included proxies for some of the most frequently mentioned reasons about why education might matter. The proxies available in the HRS included measures of cognition and memory, past health behaviors such as smoking and drinking, job-related environmental hazards, early-life health outcomes and economic environments, parental education, and parental health.[11]

Within this list of expanded variables, the only ones that mattered in terms of their statistical significance and in reducing the size of the effects of education were the current self-evaluation of childhood health and economic status and parental health as measured by age of death of each parent. These results are summarized in Table 5. For the major health onsets, both self-assessed better health status and better economic status during childhood reduce the risk of incurring a serious health onset in one's 50s and early 60s even after controlling for current health and economic status. In their support for the delayed health impact of early childhood exposures, these results are consistent with the research reported by Barker (1997), although his specific hypotheses related to the intrauterine environments. In the minor onset specification in Table 5, measures of parental health make a difference. Having a living parent or having a parent who was older when he or she died tends to reduce the likelihood of the onset of new chronic conditions at these ages. Whether this association between parental health and health during one's 50s reflects genetic factors, shared household economic and health environments during childhood, or something else would be speculative at the stage of our knowledge. Since the impact of education remains after including these variables in Table 5, my overall conclusion is that collectively these additional factors explain some but by no means all of education's ability to predict the future onset of a chronic condition.

Another clue to why education may be so critical concerns the role it plays in self-management of disease (Goldman and Smith 2002). A positive trend in recent decades has been the development of many new effective therapies for disease management. While clearly beneficial, these therapies can often be complicated and difficult for patients to fully adhere to, and

TABLE 5 Probits predicting the future onset of major and minor chronic conditions

	Major condition		Minor condition	
SES indicator	**Estimate**	**Chi square**	**Estimate**	**Chi square**
Income	0.0456	0.93	–0.0044	0.00
Wealth	–0.0040	1.60	–0.0001	0.00
Change in stock wealth	–0.0008	1.06	0.0003	0.75
12–15 years schooling	–0.0783	2.66	–0.0527	1.38
College or more	–0.0483	0.52	–0.0927	2.33
Health excellent or very good as child	–0.0870	4.68	0.0042	0.01
Not poor during childhood	–0.0949	6.31	0.0155	0.20
Mother's education	0.0028	0.18	0.0004	0.00
Father's education	–0.0018	0.09	–0.0046	0.72
Father alive	–0.1362	1.34	–0.2001	3.32
Age of father at death	–0.0001	0.00	–0.0014	0.88
Mother alive	–0.0743	0.49	–0.2465	6.51
Age of mother at death	–0.0002	0.09	–0.0028	4.60

NOTE: Models also control for presence of baseline health (self-reported health status, functional limitations, and the existence of specific chronic condition) and a standard set of health risk factors (smoking, drinking, and BMI). In addition, sex, race, ethnicity, and region of residence are included. Income and wealth measured in $100,000 of dollars.
SOURCE: Calculations by author from first five waves of the US Health and Retirement Study.

consequently for treatment of many diseases adherence rates are often alarmingly low. The question Goldman and I asked was what role education played in self-management.

I illustrate our findings with one of the diseases we investigated, diabetes.[12] New treatments for diabetes are known to be efficacious, but the treatment places great demands on a patient's ability to self-monitor his or her condition. One study we did was based on a major clinical trial: the Diabetes Control and Complications Trial. In the trial, patients with type 1 diabetes were randomized into treatment and control groups. The treatment arm involved an intensive regimen in which there was close self and external monitoring of blood glucose levels and encouragement of strict adherence. In particular, patients in the treatment arm were seen weekly until a stable treatment program was achieved. While not insignificant, the treatment in the control arm consisted of a more standard regimen and far less intrusive external monitoring of patients.

Table 6 shows that before the intervention there were large differences across education groups in several measures of good behaviors. For measures such as checking blood, following insulin regimens, exercise, or smoking, those with less education were not doing as well. Given these initial but unsurprising baseline differences by education in adherence to good

TABLE 6 Educational differences in treatment adherence at Diabetes Control and Complications Trial baseline

Measure of adherence	Post-graduate degree	College graduate/ some college	HS degree/ some secondary
Number of times self-monitored blood glucose per week	8.8	7.7	6.7
Missed insulin injection at least once in past month (%)	4.3	6.0	9.2
Did not follow insulin regimen at least once in past month (%)	15.7	25.2	26.6
Did not self-test blood or urine at least one day in past month (%)	66.1	74.1	77.2
Minutes of very hard exercise per week	58.1	49.6	19.7
Currently smoking cigarettes (%)	16.5	19.2	40.8

SOURCE: Goldman and Smith (2002).

practice, we hypothesized that imposing a good behavior regimen—which is essentially what the rigorous treatment regimen did—would impart more benefits to the less educated, who were having more problems with treatment to begin with.

We used an objective health outcome measure in the trial—glycosolated hemoglobin, which measures the amount of sugar binding to the blood. Higher levels indicated worse control. The impact of enforcing a common treatment regime can be obtained by subtracting what normally would occur (the control sample) from what took place under an enforced treatment regimen (the treatment sample). The data in Table 7 demonstrate that while persons in all education groups benefited from being in the treatment arm, the benefits from enforced better adherence relative to the control group were largest for the least educated (see the final row in Table 7). Thus, a differential ability to adhere to beneficial albeit complicated medical regimens appears to be one reason for the association between education and health outcomes for the chronically ill.

In our study, Goldman and I also provided evidence on why education might matter for adherence. Once again, two factors that did not matter in promoting better adherence were household income and having a better memory. By contrast, higher-level aspects of abstract reasoning, which included the ability to internalize the future consequences of current decisions, appeared to promote adherence.

Additional research on why education matters greatly should receive high priority. One possibility is that the education experience itself is simply a marker for personal traits (reasoning ability, rates of time preference, etc.) that may lead people to acquire more education and to be healthier. But education may also help train people in decisionmaking, problem solv-

TABLE 7 Educational differences in treatment impact for diabetics

	Glycosolated hemoglobin		
Group	**Post-graduate degree**	**College graduate/ some college**	**HS degree/ some secondary**
Conventional therapy only (n=495)			
Baseline	8.42	8.76	8.96
End of study	8.88	9.08	9.59
Difference	0.46	0.32	0.63
Intensive treatment only (n=490)			
Baseline	8.04	8.86	8.93
End of study	7.18	7.30	7.43
Difference	–0.85	–1.56	1.51
Treatment effect[a]	–1.31	–1.88*	2.14**

*p<.10; **p<.05
[a]Treatment effect is the improvement in glycemic control among the intensive treatment group relative to conventional therapy. Significance levels are for a test of equivalence with the postgraduate category and control for duration in study, sex, marital status, and age.
SOURCE: Goldman and Smith (2002).

ing, adaptive skills, and forward-looking behavior, all of which have fairly direct applications to a healthier life. Education may well have biological effects on the brain, which result in improved cognitive function and problem-solving ability, some of which may impart benefits to choices made regarding one's health. This is similar to the argument that more active brain functioning at a young age delays the onset of dementia.

The SES health gradient and the life course

The steady negative progression in health and disease as we age is well established. Long before age 51, the minimum age entry point for the HRS samples on which the previous analyses are based, a slow but accelerating decline in average health status has taken place. Less well established is the shape of the SES health gradient across age groups. Imagine that all we knew about the SES health gradient is what the AHEAD sample (originally those over age 70) or the HRS sample (originally those aged 51–61) was able to tell us. In Figures 1 and 2, in the AHEAD sample we would only observe that portion of the graph above age 70, which is demarcated by the vertical solid line at that age. While we would begin with an income–health gradient among the youngest AHEAD respondents, what we really would be monitoring is the demise of the gradient. Indeed, among the oldest AHEAD respondents, there is hardly any income gradient to health.

Since most health differences with income are disappearing, it should not surprise us in this sample that income does not affect health. When we add the age groups contained in the other HRS cohorts so that the data consist of the age groups past 50 (indicated by another vertical solid line), the income gradient with health stands out more clearly. But all we might really have done is to add additional ages to our illustration of the demise of the health–income gradient.

We know from Figures 1 and 2 that ages before 50 are very much the mirror image (now expanding with age) of what happens subsequently. It is legitimate to ask whether conclusions drawn about the meaning of the SES health gradient over ages during which the gradient is withering away will generalize to the whole life course, especially to those ages during which it is emerging.

To address this question, I first use the Panel Study of Income Dynamics (PSID), which has gathered almost 30 years of extensive economic and demographic data on a nationally representative sample of approximately 5,000 (original) families and 35,000 members of those families. PSID is recognized as the premier general-purpose survey measuring several key aspects of SES. Details on family income and its components have been gathered in each wave since the inception of PSID in 1967. Starting in 1984 and in five-year intervals until 1999, PSID has asked a set of questions to measure household wealth.

Although not traditionally known as a health survey, PSID has been collecting information on self-reported general health status (the standard five-point scale from excellent to poor) since 1984. Starting in 1999 and for subsequent waves, PSID has obtained information on the prevalence and incidence of chronic conditions for the respondent and spouse: heart disease, stroke, heart attack, hypertension, cancer, diabetes, chronic lung disease, asthma, arthritis, and emotional, nervous, or psychiatric problems. In addition to the prevalence in 1999, individuals were asked the date of onset of the condition and whether it limited their normal daily activities. The time of the onset of a health shock can be identified (keeping in mind issues related to recall bias), and the impact of these new health events on labor supplies, income, and wealth can be estimated.[13]

PSID offers several key additions to the research agenda. First, as the data provided in Figure 1 suggest, the nature of the SES health gradient may vary considerably over the life cycle. In contrast to HRS, PSID spans all age groups, allowing us to examine behavior over the complete life cycle. Labor-supply effects induced by new health events may be particularly sensitive to life-cycle stage: for example, following shocks that occur in the late 50s or early 60s individuals may select an option they would have chosen in a few years anyway—retirement. Second, the long-term nature of PSID allows one to estimate the impact of health and SES innovations over long

periods of time, even decades. It may well be that health responds to changes in financial measures of SES but only after a considerable lag.

Table 8 displays information on onset of major and minor chronic conditions in four age groups. Onsets during the previous 15 years are placed into three five-year windows—1994–99, 1989–93, and 1984–88. Both in cross-section (reading across a row) and within cohort (reading up a column) disease onset increases rapidly with age. While less common than for those in the HRS age ranges, health episodes for PSID respondents less than 50 years old are not negligible. Among those in their 40s in the 1999 wave, 13 percent had previously had a major disease onset at some time in their lives, and 39 percent have a minor chronic health condition. In the five years before 1999, 7 percent of these 40-year-olds experienced a major disease onset while 23 percent reported a new minor onset.

Table 9 lists the estimated impacts of a new major health onset that took place between 1995 and 1999 on three outcomes: the probability of continuing to work, the change in household income, and the change in household net worth. To detect the possibility of an age pattern, I present the impacts of the major health events for three age groups, all measured in 1994.[14] The most unambiguous results apply to labor supply, where the largest impact of a new severe health shock takes place among those in their 50s or early 60s. This may not be surprising since people in the preretirement years may be simply quickening the inevitable movement into retirement. While there are legitimate questions about robustness of results since income and household wealth are much harder to measure and the timing of onset given the use of retrospective data less certain, it appears that the largest impact on family income and wealth also occurs among those aged

TABLE 8 Percent experiencing an onset of major and minor conditions by age

	Age group (years)			
	Less than 41	**41–50**	**51–61**	**Over 61**
Major onset				
1994–99	3.9	7.2	12.9	26.0
1989–93	1.5	3.4	6.9	12.0
1984–88	0.6	1.4	4.2	6.0
1999 major prevalence	7.0	13.3	26.1	46.0
Minor onset				
1994–99	12.2	23.1	28.8	30.3
1989–93	3.9	10.4	16.7	23.7
1984–88	1.7	3.9	8.0	12.6
1999 minor prevalence	17.9	38.6	54.7	72.6

SOURCE: Calculations by author from 1999 PSID.

TABLE 9 Impacts of a new major health shock, 1995–99

Impact	Ages (years)		
	Less than 51	51–61	Over 61
Change in employment	–0.084	–0.307	–0.202
Change in family income	–488	–2,731	–107
Change in net worth	–2,889	–8,789	–1,507

SOURCE: Calculations by author from the US Panel Survey of Income Dynamics.

51–61 years. The offsetting factor to this ranking may be that disease onsets at a younger age affect people for a longer period of time so that their impacts, while smaller when measured in a set time interval, have the potential to grow over longer periods of time.

PSID can also be used to investigate the effect of SES on health across the full life course. Table 10 summarizes my results predicting future onset of major chronic conditions. Following the HRS format, I use three financial measures of SES: baseline levels of household income and household wealth and the increase in stock wealth observed over the period covered by the health shock. Consistent with the time frame allowed by the wealth

TABLE 10 Does SES predict future major disease onsets? (ages 21 years and older—PSID)

SES indicator	First 1–5 years		6–10 years		11–15 years	
1984 baseline						
Income	0.0013	(1.39)	0.0010	(0.11)	–0.0080	(1.14)
Wealth	0.0002	(0.54)	0.0001	(0.32)	0.0003	(0.97)
Change in stock wealth	0.0020	(0.74)	0.0001	(0.10)	0.0006	(2.40)
12–15 years schooling	–0.1217	(1.25)	–0.2160	(2.82)	–0.1312	(1.94)
College or more	–0.2834	(2.14)	–0.3238	(3.02)	–0.2888	(3.09)
1989 baseline						
Income	0.0016	(0.25)	–0.0030	(0.71)		
Wealth	–0.0007	(0.76)	0.0004	(1.11)		
Change in stock wealth	0.0010	(0.51)	0.0006	(2.30)		
12–15 years schooling	–0.1971	(2.73)	–0.1489	(2.30)		
College or more	–0.3170	(3.22)	–0.2743	(3.09)		
1994 baseline						
Income	–0.0089	(1.91)				
Wealth	0.0005	(1.21)				
Change in stock wealth	0.0004	(1.28)				
12–15 years schooling	–0.1387	(2.27)				
College or more	–0.1844	(2.18)				

NOTE: Financial variables expressed in $10,000. z statistics based on robust standard errors.
SOURCE: Calculations by author from the US Panel Survey of Income Dynamics.

modules, three time periods are used with alternative baseline years: 1984, 1989, and 1994. The occurrence of major health events is measured over five-year intervals.

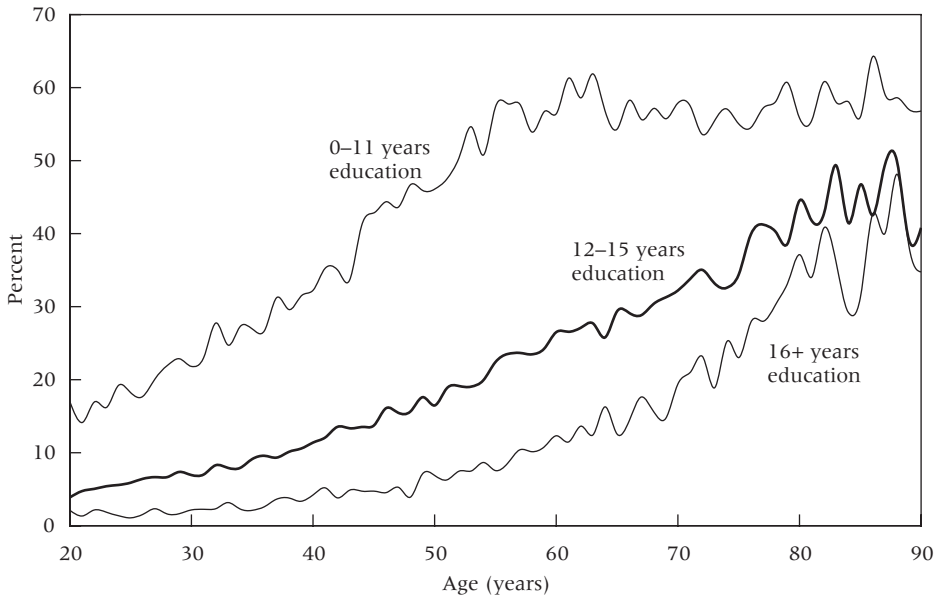
These results closely parallel those obtained for the older populations represented by the HRS and AHEAD. Whether one looks at the relatively short horizon of the next five years or more than a decade ahead, all three financial measures of SES are very poor predictors of future health outcomes. While not shown in Table 10, this conclusion remains when longer lag structures of income are included in the model. Since these longer lag structures are an approximation to permanent income, the lack of predictability of income is not because transitory measures of income are being used. These longer-horizon PSID results on financial measures of SES are quite powerful in that they partly respond to the objection that one may have controlled for most of the indirect effects of SES by conditioning on baseline attributes. In this case, the conditioning variables are sometimes measured more than a decade earlier.

Once again, I do not imply that SES cannot predict future health events: education is a statistically significant predictor across both short and long horizons. To me it is nothing short of remarkable that even after one controls for an extensive array of current health conditions, persons with less schooling are much more likely to experience the onset of a major negative health shock—effects that persist into old age.

The basic question is whether our main conclusion about the dominance of education over financial measures of SES is sustained when we consider the complete life course. To place the issue in perspective, Figure 3 plots the education gradient for those in fair or poor health in the same manner as Figure 2 did for income. In several key dimensions, the income and education health gradients are quite similar. Whether stratified by income or education, higher SES is associated with better health, a relationship that first expands with age up to around age 50 and then contracts, and one that is highly nonlinear with the lowest SES group in much worse health than all the others. But there are some differences as well. Most important, unlike income the education health gradient is more persistent and never fully disappears at either very old or very young ages.

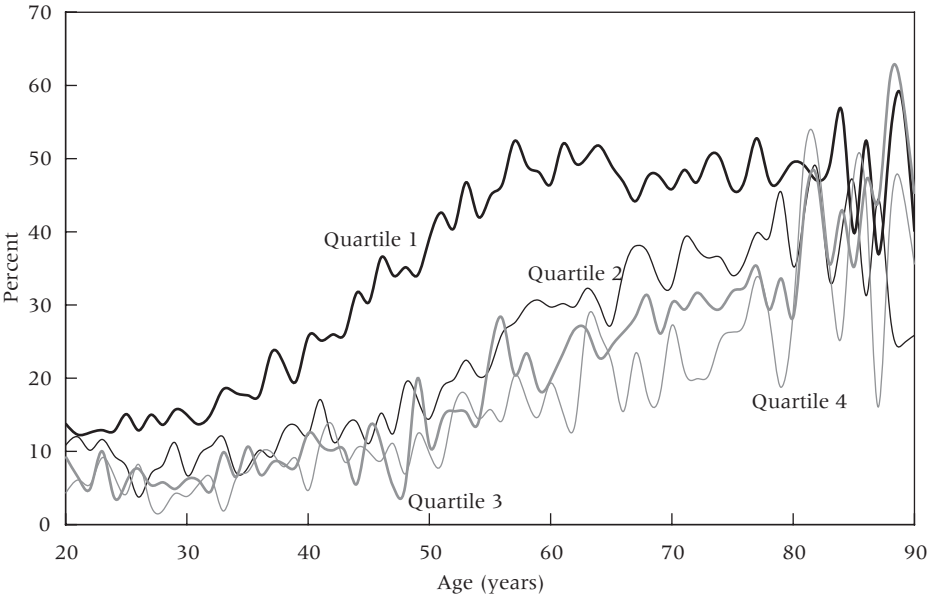
Given the strong correlation of income and education, the question of whether the SES health gradient is due to income or education requires examining them jointly. Those in lower SES groups are more likely not to be married, which alone produces lower family incomes. To control for this confounding factor, I limit samples in what follows to married individuals. Figure 4 displays the health gradient by income quartile among those with 0–11 years of schooling. Now the strong income effects that were present especially at younger ages—say below age 50—virtually disappear with one key exception: those in the lowest income quartile remain in much worse

FIGURE 3 Percent reporting fair or poor health status by education



SOURCE: Calculations by author from the pooled National Health Interview Surveys 1991–96.

FIGURE 4 Percent of married male respondents with 0–11 years of education reporting fair or poor health status by age-specific income quartiles



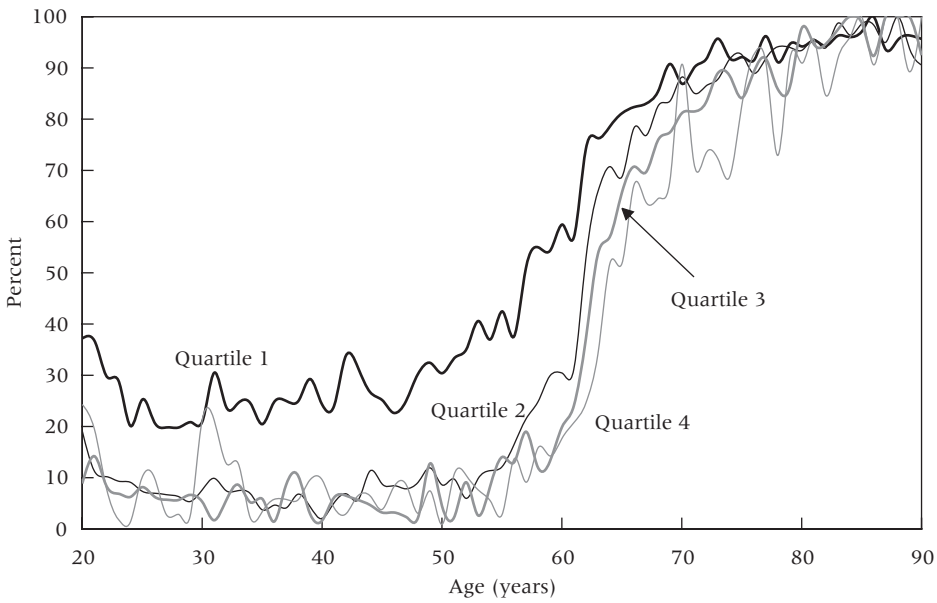
SOURCE: Calculations by author from the pooled National Health Interview Surveys 1986–96.

health. While not shown here, the same story applies to the other two education groups, those with 12–15 or 16-plus years of schooling.

Why is the bottom income quartile so distinct as a signal of poor health even after controlling for education? A clue is contained in Figure 5, which plots for those with 0–11 years of schooling the fraction who are not working within each income quartile. The basic age pattern is not surprising, with labor force participation rates declining rapidly during ages 50–65 as retirement looms. Comparing Figures 4 and 5, the patterns across income quartiles are remarkably similar. There is not much difference among the top three income quartiles, but the bottom income quartile stands apart. Even at relatively young ages—30s and 40s—a large fraction of those in the bottom income quartile are not working, strongly suggesting that their low incomes are a consequence of not working.

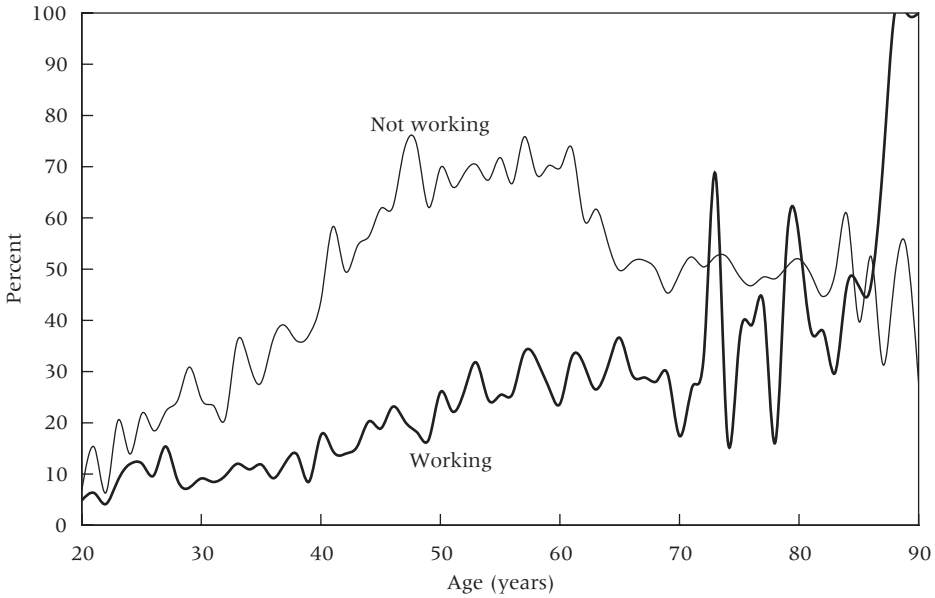
Why are so many people in the lowest income quartile not in the labor force even in the prime of their lives? Figure 6 completes the circle and provides the answer. This graph plots within education groups the fraction in fair or poor health by their labor force status. Those who are not working are much more likely to report being in poor or fair health. At age 50, for example, 70 percent of those not working report themselves in either poor or fair health—a figure some 40 percentage points larger than among those who are working.[15]

FIGURE 5 Percent of married male respondents with 0–11 years of education, not working in labor force, by age-specific family income quartile



SOURCE: Calculations by author from the pooled National Health Interview Surveys 1986–96.

FIGURE 6 Percent of married male respondents in poor or fair health by whether or not they are currently working



SOURCE: Calculations by author from the pooled National Health Interview Surveys 1986–96. Sample is limited to those with 0–11 years of schooling in the lowest income quartile.

Conclusion

In this chapter, I reexamined one of the most important and mysterious social science issues of the day: the substantial gradient of health according to socioeconomic status. My midterm report based on my personal voyage of discovery is this. First, I found that causal pathways from health to financial measures of SES are very important: new serious health events have a quantitatively large impact on work, income, and wealth. The current literature mistakenly tends to downplay this pathway. SES also affects future health outcomes, although the primary factor here is years of schooling and not an individual's financial resources.

Contrary to widespread and deeply held beliefs within the policy and research community, my empirical evidence demonstrated that the principal financial measures of SES—household income and household wealth—do not seem to be related to individual health outcomes. But in research, one finding always begets another puzzle. There is growing evidence, including some presented here, that measures of economic circumstances during childhood have a bearing on health outcomes later in life. Parental incomes appear to be central correlates of the onset of some critical childhood diseases, which then set the stage for the adult SES health gradient (see the

excellent discussion in Case, Lubotsky, and Paxson 2002; Case, Fertig, and Paxon 2004; Smith 2004). In a more historical vein, certain months of birth that coincide with the nutritional benefits of the agricultural cycle are associated with added years of life even at older ages (Doblhammer and Vaupel 2001). Why is health apparently so sensitive to financial resources in the early years of life, an influence that then disappears as we age? While the influence of money may dissipate, the impact of how we are stratified by other aspects of SES decidedly does not. Whatever the origins of this stratification, it has profound implications for population health, where the consequences are serious and where the core reasons remain a mystery.

Notes

This research was generously supported by grants from the National Institute on Aging. This chapter was presented at seminars at the University of California, Berkeley and Princeton University, where very helpful comments were received.

1 Socioeconomic status (SES) is defined as any one of several composite measures of social rank, usually including income, education, and occupational prestige.

2 Similar conclusions were reached by Case and Deaton (2002).

3 For an insightful debate about the conditions under which coefficients that are zero or stationary also reveal something about causality, see the paper by Adams et al. (2003) and the comments on that paper in the same volume.

4 Health shocks that took place between the other HRS waves had similar types of effects and thus are not repeated here. See Smith (2003) for more details on the full set of impacts.

5 The estimates in Table 1 summarize mean impacts. Effects of new health shocks on the tails of the out-of-pocket medical expense distribution were much larger (see Smith 2003).

6 The only component not included in this wealth loss measure is any change in household consumption other than medical expenses. Smith (1999) outlines the conditions under which other total household consumption increases or decreases as the result of a new medical event.

7 A controversy that has occupied a substantial part of the recent literature has investigated the hypothesis attributed to Wilkinson (1996) that measures of societal levels such as income inequality affect individual-level health. For an excellent review and critique of the theoretical and empirical literature on this hypothesis see Deaton (2002). Deaton concludes that at least in the United States and Britain there is little empirical support for this view, at least as when it is confined to income inequality per se.

8 Since the sample is restricted to those who were in the HRS for all five waves, this analysis ignores the relationship of SES with attrition and mortality. Given the age range of HRS and PSID respondents, mortality selection is unlikely to be critical. That is clearly not the case in the AHEAD sample. For a model that incorporates mortality selection and deals with the causality issue in more detail see Adams et al. (2003).

9 One limitation of using increases in stock market wealth is that these increases are concentrated at the top of the income distribution (see Smith 2000) so that one is examining the effects of financial resources on health in that subset of the population where the impacts are likely to be smallest. In addition, the exogeneity argument is more credible in the time dimension than the person dimension since for the latter one needs to explain why some people have accumulated so much stock in the past thereby exposing them to the possibility of larger capital gains in the future. Obtaining other believable measures of exogenous

changes in financial resources that more evenly span the entire income distribution would be very useful.

10 See Deaton (2002) for an insightful elaboration of these issues.

11 HRS data on some concepts are limited but they do record whether one smoked in the past and whether one was exposed on the job to a health hazard (and the number of years of exposure), the education of parents, whether or not each parent is alive, and, if deceased, the age of death, self-assessed general health status as a child (the same five-point scale), and an assessment of the economic environment in which one lived during childhood. The specific question for health was "Consider your health while you were growing up, from birth to age 16. Would you say that your health during that time was excellent, very good, good, fair, or poor?" The specific question for economic circumstances was "Now think about your family when you were growing up, from birth to age 16. Would you say your family during that time was pretty well off financially, about average, or poor?"

12 We found similar results for persons with HIV.

13 For a detailed analysis of the quality of the PSID health data, see Smith (2004).

14 Similar to the HRS findings, new minor health events had no detectable effects on any of these outcomes.

15 Similar conclusions are reached in an insightful paper by Case and Deaton (2002) where the primary focus is gender differences by SES and age.

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