THE RISING SIGNIFICANCE OF
EDUCATION FOR HEALTH?*

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ABSTRACT

This paper uses data from the National Health Interview Survey (NHIS) to track trends in self-reported health by education level in the United States over the past 25 years. Results corroborate the well-known finding that self-reported health is strongly associated with education level. In addition, new findings show that differences in self-reported health between education groups have increased since the early 1980s, at least among adults ages 70 and over. Educational differences in health for younger adults, by contrast, have remained stable (ages 40 to 69) or even contracted (ages 30 to 49). These trends do not merely reflect change in the social and demographic composition of education groups, but rather change in the nature of the association between education and health. The findings are mixed news for the growing number of health policy makers and researchers wishing to reduce disparities in health between different segments of the U.S. population, and further complicate descriptions of inequality trends in the United States over the past 25 years.

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The last decades of the twentieth century saw a sharp upswing in levels of social and

economic inequality in the United States. In line with the predictions of Bell (1973) and

other early post-industrial theorists, much of the trend reflects increasing inequality

between education groups, particularly between college-educated men and women and

those without college degrees. For example, research on economic inequality shows that

increasing differences in earnings between education groups account for about one-third

of the increase in overall wage inequality since the early 1980s (Bernhardt et al. 2001,

p. 7). Differences in work conditions, employment benefits, and job satisfaction by

education level have also apparently increased (Fligstein and Shin 2004). Scholars like

Freeman (1999) have warned that this "new inequality" is leading toward a "two-tiered

society…in which the successful and upper-middle classes live fundamentally different

from the working classes and poor" (p. 4). If so, education is arguably the main dividing

line by which these tiers are split.

In this article I examine whether and how differences in *health* by education

level have changed in the United States over the past 25 years. In particular, I want to

determine whether educational differences in health are *larger* today than they were in

the early 1980s. Health, like wealth, is a main dimension of individual well-being, yet

researchers know much less about trends in health differences by education level than

about trends in earnings or income differences. A large body of research confirms that

education is strongly associated with a broad range of measures of health and longevity,

as described in detail below. Much less is known, however, about whether and how the strength of this association has changed over time. Evidence of increasing educational differences in health would bolster claims of the growing importance of education for stratification, whereas evidence of declining differences would suggest that in at least one important social domain the effect of education on future life chances may be losing some of its force.

By examining trends in health differences between education groups, I also contribute to the large and growing literature on social disparities or inequalities in health among the U.S. population. Understanding and reducing the large disparities in health that exist between both socioeconomic and racial/ethnic groups in the United States has emerged as one of the top goals of U.S. health policy and research in the early twenty-first century (House 2002). For example, a widely-publicized report by the U.S. Department of Health and Human Services (2002) identifies the two overarching goals of current health policy as (1) boosting life expectancy and overall quality of life, and (2) eliminating disparities in health between different segments of the population. Prior research in this area has made significant progress in identifying the mechanisms or pathways through which social factors like education influence both physical and mental health, and in establishing how the nature and strength of these effects may vary over the life course. In this article I explore the additional possibility that the relationship from education to health may vary over time as well.

First I review prior research on education and health, focusing on the relatively few prior studies of time trends. Then, using data from a repeated health survey of the non-institutionalized U.S. population and a simple but commonly-used measure of self-

reported health status, I present new estimates of time trends in health differences between education groups from 1982 to 2003. To jump ahead, I find that such differences in health have indeed increased since the early 1980s, at least among adults ages 70 and over. Educational differences in health among younger adults, however, have been either stable or even contracting. I discuss possible explanations of the changing association between education and health, and outline an agenda for future research.

BACKGROUND

More than 30 years of research on the social determinants of health and illness shows that education is strongly associated with a broad range of measures of health and longevity, such that college graduates have better health on average than do high school graduates, and that high school graduates have better health on average than do people without high school degrees (e.g., Crimmins and Saito 2001; Elo and Preston 1996; Fuchs 1982; Grossman and Kaestner 1997; House et al. 1994; Kitagawa and Hauser 1973; Lantz et al. 1998, 2001; Marmot 2004; Mirowsky and Ross 2003; Preston and Elo 1995; Preston and Taubman 1994; Rogers, Hummer, and Nam 2000, ch. 7; Ross and Mirowsky 1999; Ross and Wu 1995, 1996). In the United States, differences in health by education level range up to 7 years or more in life expectancy and up to 12 years or more in the age at which disabling health problems first onset (Molla, Madans, and Wagener 2004, table 5).

The pathways or mechanisms linking education to health are indirect and wide-ranging. Only part of the association is explained by differences in lifestyle and health-

risk behaviors (e.g., cigarette smoking, low exercise, poor diet and body mass), or by differences in access to or utilization of health services and medical technology (Lantz et al. 1998, 2001). Part of the association may also be explained by the long-term effects on both educational attainment and adult health of social and health conditions experienced in early childhood (Conley and Bennett 2000; Hayward and Gorman 2004). But equally if not more important are such diverse mediating factors as employment, income, and work conditions (Warren et al. 2004); stress and social support (Grzywacz et al. 2004; Lantz et al. forthcoming); psychosocial and cognitive skill (Mirowsky and Ross 2003); and patient self-management (Goldman and Smith 2002). Thus, education is best described as a "fundamental cause" (Link and Phelan 1995) of health, in that it shapes a broad range of psychosocial, economic, behavioral and environmental factors which in turn influence a broad range of later health outcomes (House and Williams 2000).

The strength of the association between education and health also varies over the life course. Mounting evidence indicates that whereas college graduates are increasingly able to maintain good overall health until relatively late in life (e.g., their early 70's or later), others experience steady declines health throughout adulthood and early old age. Thus, educational differences in health are not constant across the life course, but rather increase from early adulthood to early old age, and then decline steadily thereafter (Beckett 2000; Herd 2004; House et al. 1994).[1] Moreover, if addition to this patterning by life course stage there is also a trend toward increasing educational differences in health over time, it has most likely occurred among older adults, the only age group for

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[1] For contrasting evidence that educational differences in health increase continuously throughout the life course, see Ross and Wu (1996).

which health problems are common across all education levels. A trend toward increasing health differences is much less likely to have occurred among younger adults, because ill health is relatively uncommon at this age range among people with higher education levels.

Given these findings, it is perhaps not surprising that the few prior studies of time trends have generally found evidence of persistent or even *increasing* educational differences in health since the early 1980s, particularly among adults ages 70 and over. For instance, Schoeni et al. (forthcoming) found that educational differences in old-age disability rates have been "generally widening" (p. 12) since the early 1980s, and Crimmins and Saito (2001) found "large and growing" (p. 1637) educational differences in healthy life expectancy from 1970 to 1990. Similarly, Lynch (2004) found that the association between education and self-reported health has strengthened across birth cohorts, especially at older ages (fig. 2).

These findings are further supported by the results of an earlier round of studies conducted from the late-1980s through the mid-1990s on trends in education and adult mortality. A widely-cited and highly-publicized study by Pappas et al. (1993) was one of the first to suggest that educational differences in adult mortality had widened in the United States since the mid-twentieth century (see also Feldman et al. 1989; Lauderdale 2001). Their analysis, however, was limited to a comparison of two selected time points, 1960 and 1986. Preston and Elo (1995) later updated and revised this finding by showing that educational differences in mortality had "widened for males but contracted for working-age females" (p. 476). Consistent with the idea that a trend toward increasing educational differences in health has occurred for older adults but not for

younger adults, they also found that trends were "more adverse" (p. 491) for men and women ages 65 to 74 than for those under age 65.

Recent explanations of these trends have tended to focus on the possible role of differences in knowledge of or access to health services and medical technology. Although such differences have been repeatedly shown to account for only a small part of the total association between education and health (see above), they may play a larger role in explaining why the strength of the association appears to have intensified over time. Mirowsky and Ross (2003, pp. 165-68) suggest that people with higher education levels have a better knowledge and understanding of new health services and medical technologies (e.g., specialized prescription drugs, increasingly complex and specialized medical procedures), and that this has enabled them to achieve above-average gains in health and longevity. Their logic is that "advances in science and technology favor society as a whole, but disproportionately favor those who know how to find, evaluate, and use information to best advantage" (p. 165). One could alternatively argue to similar effect that new health services and medical technologies have indeed worked to exacerbate educational differences in health, but that the mainspring behind the trend has less to do with levels of knowledge and understanding than with levels of access and material resources.

Educational differences in health-promoting behaviors such as smoking cessation, increased physical activity, and improved diet and body mass may also have worked to boost educational differences in health. Consider the example of smoking cessation. Data from the National Center for Health Statistics (NCHS) show that the age-adjusted prevalence of cigarette smoking has plunged in the United States over the

past 30 years. The percentage of U.S. adults ages 25 and over self-reporting as "current smokers" was roughly 22 percent in 2001, down from nearly 37 percent in 1974 (NCHS 2003, table 60).[2] However, the rate at which the prevalence of smoking has declined has also varied by education level, with the largest declines recorded among people with four-year college degrees. Whereas the prevalence of cigarette smoking among high school graduates dropped from 36 percent in 1974 to 28 percent in 2001, the prevalence among college graduates dropped from over 27 percent to less than 11 percent. Other things being equal, these trends predict larger gains in health among college graduates than among lower education groups.

In addition to these relative and absolute gains in health-promoting behaviors, the economic standing of college graduates relative to lower education groups has also greatly improved. As noted briefly above, a large body of research in both sociology and economics shows that differences earnings, work conditions, employment benefits, and job satisfaction by education level have all increased since the early 1980s, particularly between college-educated men and women and those without college degrees (e.g., Bernhardt et al. 2001; Fligstein and Shin 2004; Heckman and Krueger 2003; McCall 2001; Morris and Western 1999). The economic boom and stock market run-up of the 1990s likely produced increasing differences in wealth by education level as well. The factors responsible for these trends are still hotly debated, but likely include technological change, changes in labor market institutions, and trade globalization and increased foreign competition. The trend toward increasing educational differences in earnings and work conditions has most strongly affected

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[2] "Current smokers" are defined as people reporting (1) that they currently smoke at least some days of the week and (2) that they have smoked more than 100 cigarettes over the course of their lifetimes.

younger adults, so the full range of health consequences may not be known for another 30 to 40 years. Increasing inequality in wealth and stock holdings, by contrast, could have more immediate short-term effects, because it has affected both younger and older adults.

Finally, it is also possible that a trend toward increasing educational differences in health reflects change in the composition of education groups as opposed to change in the nature of the relationship between education and health. The overall distribution of education has changed markedly over the past 20 years, as the average education level in the population continues to increase. From 1982 to 2002, the percentage of U.S. adults ages 25 and over with at least a high school degree increased from 71 percent to 84 percent, and the percentage of adults with a college degree increased from roughly 18 percent to nearly 27 percent (Newburger and Curry 2000, table A-2). Most of these gains reflect the replacement in the population of older, less-educated cohorts by younger, more-educated cohorts. College attendance and completion rates have edged-up only slightly since the early 1980s.

More important for the present analysis is that the composition of education groups by such social and demographic characteristics as age, gender, and race has also likely changed. For example, in the data used in the analysis below, the average age of the highest education group (respondents with 16 or more years of formal schooling completed) increased from roughly 46 years in 1982 to nearly 49 years in 2003. Part of this is due to change in the distribution of education, and part is due to declining mortality and attendant gains in life expectancy. The important point, however, is that

one must account for such composition change when estimating trends in educational differences in health, to avoid a source of bias.

RESEARCH STRATEGY

My objective in the remainder of this article is to present new estimates of time trends in educational differences in health from 1982 to 2003. I extend prior research in this area in three important ways: (1) by examining trends over a more recent period and for a greater number of years, (2) by examining whether and how trends have varied by age group, and (3) by accounting for the possibility that trends reflect change in the composition of education groups as opposed to change in the nature of the relationship between education and health.

Data

The analysis is based on data from the National Health Interview Survey (NHIS), a repeated cross-sectional survey of the non-institutionalized U.S. population conducted annually by the National Center for Health Statistics (NCHS). I included in the analysis data from all 22 surveys conducted from 1982 to 2003. I used 1982 as the starting point because it is the first year the self-reported health measure (described below) was included in the survey.[3] The 2003 survey is the most recent for which data are publicly available. Focusing on the years 1982 to 2003 is also strategic because it coincides with the period in which other dimensions of social and economic inequality in the United States appear to have increased.

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[3] Earlier surveys included a similar measure but with a different number of response categories. Prior to 1982 there were four response categories, and beginning in 1982 there were five (Chyba and Washington 1990).

The sample for each survey year consists of the members of a nationally representative sample of U.S. households. Households were selected using a multistage cluster sampling design. Data was collected for all members of selected households, via self-reports for respondents ages 17 and older, and via proxy-response for children under 17 and for adults not present at the time of the interview. For the purpose of the present analysis I excluded respondents under age 30, whose school careers may not have been finished at the time they were interviewed. The average sample size after excluding the younger respondents is roughly 55,000 individuals per year (unweigted). To account for the complex sampling design, I used survey sampling weights throughout the analysis.[4]

Measures

*Health.--*Health is measured using a single-item measure of self-reported health status. For this item respondents were asked: "Would you say {subject name's} health in general is excellent, very good, good, fair, or poor?" Despite its simplicity, this type of self-reported health measure is one of the most commonly-used health measures in social scientific research, and has been repeatedly shown to have high test-retest reliability, and to be very predictive of mortality and other health outcomes (Benjamins et al. 2004; Idler and Benyamini 1997; Lundberg and Manderbacka 1996). It is also the only measure of general health status in the NHIS that has remained largely unchanged

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[4] Other datasets I considered using include the Panel Study of Income Dynamics (PSID), the National Health and Nutrition Examination Survey (NHANES), and the General Social Survey (GSS). The PSID began measuring self-reported health in 1984, but as a panel study is not continuously representative of the national population and thus not well suited for the present analysis. The NHANES collects detailed health information for a large sample of individuals, but was not conducted at regular intervals over this period. The GSS has regularly included a measure of self-reported health, but does not have a large enough sample size to estimate trends separately by age group, an important component of the analysis below.

across periodic revisions of the survey instrument. For example, the survey's measure of general limitation in physical functioning was changed significantly in 1997, and thus responses to this measure are not directly comparable over time.

There are several possible methods of scoring the five response categories (Powers and Xie 2000, pp. 202-6). One is to simply assign each category a number from 1 to 5, such that respondents answering "excellent" are assigned the value 1, respondents answering "very good" are assigned the value 2, and so on. The resulting variable could be analyzed using ordered logit or ordered probit regression models. The problem with this method, however, is that it assumes an equal distance between adjacent response categories (e.g., that the distance between "fair" and "poor" is equal to the distance between "fair" and "good"), and prior research has found this assumption to be inappropriate for measures of self-reported health (van Doorslaer and Jones 2003). To avoid this problem, an alternative scoring method is needed. In this analysis I adopted the common solution of collapsing the measure into a dichotomous variable coded 1 for people reporting "poor" or "fair" health and 0 for people reporting "good," "very good," or "excellent" health. This approach loses information but avoids having to make inappropriate assumptions about the distance between adjacent response categories. To assess the robustness of the results to alternative scoring methods, I also performed the analysis comparing respondents reporting "poor," "fair," or "good" health to those reporting "very good" or "excellent" health. The results were very similar.

Education.--Education is measured with a self-report of the highest level of formal schooling completed. I collapsed the measure into an ordinal variable with categories for college graduates (16 or more years of formal schooling completed), high school

graduates (12 to 15 years of formal schooling completed), and people without high school degrees (less than 12 years of formal schooling completed). I used these categories in part because they coincide with the assignment of major educational credentials (e.g., high school degree and college degree), and in part because they mark the points on the education distribution at which differences in self-reported health by education level are greatest.

I addressed the issue of compositional change in two ways. First I tried accounting for such changes directly by adjusting my estimates for a limited number of social and demographic control variables. The specific variables included in the analysis are described in detail below. The main limitation of this approach is that there may be yet additional compositional changes for which it is more difficult to control—e.g., changing patterns of selection into education groups on the basis of cognitive ability or preexisting health problems. Thus, for the second approach I performed the analysis using a relative measure of educational attainment instead of the fixed education categories. To construct the measure, I first divided the sample for each year into three separate age groups: 30-49, 50-69, and 70 and over. Then I further divided each age group into three equal-sized groups on the basis of education level. The resulting variable divides each age group into bottom, middle, and top education terciles.[5] The division by age group was necessary because I report results of the analysis separately by age group below. The relative education measure addresses the issue of compositional change because the composition of the relative education groups has arguably changed by a much smaller amount than has the composition of the fixed

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[5] For instances in which multiple respondents clustered on the cut-off point between two terciles, I assigned these respondents randomly and in the proportions needed to create equal-sized groups.

education groups. For example, the relative size of the relative education groups is unchanging by construction. The one important exception is that in the relative education groups the average education level increases steadily over time, whereas in the fixed education groups the change is much smaller.

Control Variables.—A limited number of social and demographic control variables were included for gender (coded 1 for women and 0 for men); race (coded white, black, and other); marital status (coded married, separated or divorced, widowed, and never married); age (coded in years); and geographic region (coded 1 for South and 0 for non-South). These variables capture five main dimensions along which the composition of education groups has changed, and have been found by much prior research to also correlate with health. For reasons discussed in the results section below, I also included a control variable for surveys conducted after 1996 (coded 1 for surveys conducted after 1996, and 0 otherwise).

Analysis

To determine how differences in self-reported health by education level have changed since the early 1980s, I first calculated basic descriptive trends showing how the percentage of respondents reporting fair or poor health changed from 1982 to 2003 for each education group, and how the differences in these percentages changed. I calculated trends in both (1) absolute percentage-point differences and (2) proportionate differences as measured by relative odds ratios. Analyses of absolute versus relative differences in health sometimes yield conflicting results, so it is important to look at both. None of the descriptive analyses were adjusted by age or other control variables.

To test the statistical significance of the trends and to adjust for changes in the composition of education groups, I then pooled the data from all 21 surveys and estimated a series of binary logistic regression models of the following general form:

$$\text{logit}(p_{it}) = \alpha + \beta_1 e_{1it} + \beta_2 e_{2it} + \beta_3 y_{it} + \beta_4 [e_{1it} \times y_{it}] + \beta_5 [e_{2it} \times y_{it}], \qquad (1)$$

where p_{it} is the probability of reporting fair or poor health for the ith respondent in survey year t; e_1 and e_2 are dummy variables for people without high school degrees and high school graduates, respectively (so college graduates denote the reference group); and y is a linear index of survey year coded from 0 for the 1982 survey to 22 for the 2003 survey (so the index value increases by 1 for each subsequent survey year). The key terms in the equation are β_4 and β_5, which show how the difference in the log-odds of reporting fair or poor health between college graduates (the reference group) and either high school graduates (β_5) or people without high school degrees (β_4) has changed over time. A positive coefficient indicates an increasing difference, a negative coefficient a narrowing difference. The terms β_1 and β_2 denote the health difference in 1982 between college graduates and either high school graduates (β_2) or people without high school degrees (β_1), and β_3 denotes the average annual change in the log-odds of reporting fair or poor health for college graduates.

I first estimated an unadjusted model that included (1) main effects for education level and the linear index of survey year, and (2) terms for the education-by-survey-year interaction (eq. 1). Then I estimated an adjusted model that added control variables for age, gender, race, marital status, geographic region, and post-1996 survey year. To determine whether trends vary by age group, I performed both the descriptive and

regression parts of the analysis separately for three different age groups: 30-49, 50-69, and 70 and over.

One limitation of the logistic regression models is that they test for change in relative educational differences in health, but not for change in absolute differences. To check the possibility that absolute differences in health have changed in a different fashion, I also performed the analysis using linear probability models instead of binary logistic models. To make the results of the linear probability models comparable to the percentages reported in the descriptive part of the analysis, I recoded the self-reported health measure 0, 100 instead of 0, 1. To address the well-known problem that linear probability models violate the ordinary least squares (OLS) assumption of constant variance in the error term across values of the independent variables, I report significance tests calculated with robust standard errors (Wooldridge 2000, ch. 8).

Finally, this type of pooled cross-sectional analysis always confronts the problem of disentangling age, period, and cohort effects. I identified the age effect by performing the analysis separately by age group, and by including an additional control for age in the adjusted regression models. The resulting trends are thus a mix of cohort and period effects. A more in-depth analysis of age, period, and cohort effects is beyond the scope of the current analysis.

RESULTS

Table 1 presents the descriptive trends showing how the percentage of respondents reporting fair or poor health has changed since the early 1980s by education level and age group. To save space, I report results for only 5 of the 22 survey years included in

the analysis. Note that none of the trends are adjusted by age or other social and demographic factors.

TABLE 1 ABOUT HERE ----- Descriptive Trends

Consistent with the findings of much prior research, the results in table 1 show large differences in self-reported health between education groups, with college graduates reporting better health on average than high school graduates, and high school graduates reporting better health on average than people without high school degrees. The association holds across all five survey years and for each of the three age groups, with the largest differences (in absolute terms) recorded for adults ages 50 to 69. For this age group, the probability of reporting fair or poor health is up to 9 percentage points lower for college graduates than for high school graduates, and up to *30 percentage points* lower for college graduates than for people without high school degrees. The results are also consistent with prior research on the patterning of educational differences in health by life-course stage, showing that only at older ages is poor health common across all education levels. Whereas for college graduates poor health is very rare until relatively late in life, for others it is a regular feature of early- and mid-adulthood.

Trends in self-reported health have varied by both education level and age group. Two findings stand out. One is that for the oldest age group reports of fair or poor health have fallen sharply for college graduates, but not for anyone else. The probability of reporting fair or poor health for college graduates was roughly 16 percent in 2003, down from nearly 23 percent in 1983. The other key finding is that trends look different for the middle and youngest age groups than for the oldest group. For the

youngest age group, the only palpable change has been a roughly five-percentage-point

drop in the probability of reporting fair or poor health for the *lowest* education group.[6]

The upshot is that educational differences in health appear to have *increased* for the

oldest age group, but not for the two younger groups.

Table 2 confirms this finding by showing trends in both absolute and relative

differences in health by education level over the same six selected survey years. I

calculated these figures directly from the percentages reported in table 1. The trends are

very similar for both absolute and relative differences, so I focus on the latter. For the

oldest age group, the odds ratio for the relative health difference between the highest

and lowest education groups increased from a low of 2.30 in 1983 to a high of 4.07 in

1998. Put another way, the odds of reporting fair or health were roughly twice as great

for college graduates as for people without high school degrees in 1983, but roughly

four times greater in 1998. Relative health differences between the other education

groups have similarly increased. Conversely, for the middle and youngest age groups,

relative health differences have been either stable (ages 50 to 69) or declining (ages 30

to 49). The decline has been especially steep in the youngest age group for the

difference between the lowest and highest education groups.

TABLE 2 ABOUT HERE ----- Relative and Absolute Differences

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[6] Additional analyses (not reported, but available upon request) suggest that at least part of this decline may reflect a change in the NHIS survey instrument as opposed to an actual time trend. Most of the five-percentage-point decline occurs between two adjacent survey years, 1996 and 1997, which also coincides with a switch to a redesigned survey instrument in 1997. The survey redesign did not involve any changes to the self-reported health item, but it is possible that other changes to the survey instrument (e.g., the addition of new questions on limitation in physical functioning prior to the self-rated health item, or the reordering of items in the questionnaire) influenced response patterns. I account for this in the regression models by including a dummy variable for surveys conducted after 1996.

The central regression results are reported in table 3. Included in this table are the logistic regression models estimated separately by age group with the full sample of data from all 22 survey years. To save space, I report coefficients for the main effects for education and survey year and for the education-by-survey-year interactions, but not for the control variables added to the adjusted models.[7] One main story is that most of the trends noted in the descriptive results also show up in the regression results. In the models for the oldest age group, the negative and significant main effects for survey year indicate that the likelihood of reporting fair or poor health has declined for college graduates since the early 1980s. In addition, both interaction terms in these models are positive and significant, indicating that educational differences in health have increased since the early 1980s for adults ages 70 and over. Conversely, in the models for the youngest age group, one interaction term is negative and significant, and the other is close to zero. The former indicates that the health difference between the highest and lowest education groups has narrowed over the past 25 years, the latter that the health difference between the highest and middle education groups has remained largely unchanged. One new finding is evidence that educational differences in health have increased for the middle age group as well (denoted by the positive and significant interaction terms in the models for this group). However, this trend does not hold up in the linear probability models, as described below. In sum, then, educational differences in health appear to have increased for older adults, but remained stable or contracted for younger adults.

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[7] The coefficients for the control variables matched prior expectations, with the likelihood of reporting fair or poor health lower for men than for women; lower for whites and other racial/ethnic groups than for blacks; lower for married people than for people who are divorced, separated, or never married; and lower for people living outside of the South than for southerners. The likelihood of reporting fair or poor health also increases with age, and declines in surveys conducted after 1996.

The other main story in table 3 is how little the estimates change after adjusting for the social and demographic control variables. To be sure, this is a relatively weak test of compositional effects, because there are likely additional types of compositional change for which I have not accounted. Nevertheless, these results provide at least some initial evidence that the trends do not merely reflect change in the basic social and demographic composition of education groups.

TABLE 3 ABOUT HERE ----- logistic regression results

Keep in mind that in the models in table 3 the coefficients for the interaction terms measure incremental change from one year to the next. To determine the full magnitude of change implied by the models, one must add up these incremental changes over the entire 22-year span. To illustrate, figure 1 plots a range of predicted values I calculated from the adjusted logistic regression models in table 3. As the figure clearly shows, the estimates imply appreciable change in the predicted probabilities over time, especially for the older age group. There are also noticeable trends for the two younger age groups, though on a somewhat smaller scale. The magnitude of these trends is masked in table 3 due to the nature of the models.

FIGURE 1 ABOUT HERE ----- Predicted probabilities

Table 4 examines whether the results are sensitive to the use of linear probability models in the place of binary logistic models. In substance this addresses the possibility that absolute and relative differences in self-reported health have changed in different ways. The logistic models test for change in relative differences, the linear

probability models for absolute differences. Comparing the results in table 4 with those in table 3, it appears that only for the middle age group do the models generate different results. The coefficients for the interaction terms are positive (denoting increasing health differences) in both the logistic models and linear probability models, but only in the logistic models do they research statistical significance. For the middle age group, then, it appears that relative differences in self-reported health have increased, but absolute health differences have not. There is also a minor difference in the linear probability models for the youngest age group, in that the interaction term for the middle education group is positive (increasing difference) and statistically significant. However, the size of the effect is very modest.

TABLE 4 ABOUT HERE ----- Linear probability model

Finally, to address the possibility of compositional change beyond what the social and demographic control variables capture, table 5 displays the results of additional logistic regression models estimated using relative (instead of fixed) education groups. The top tercile is omitted as the reference group, so the models show how differences in self-reported health between the top tercile of the education distribution and each of the two lower terciles have changed over time. Comparing the results in table 5 with those in table 3, it appears that the use of relative education groups somewhat attenuates the strength of the interaction terms in the models for both the oldest and middle age groups, suggesting that at least part of the trends are explained by additional compositional change for which I have not accounted. In the models for the oldest age group, however, the interaction term for bottom education

tercile remains positive and statistically significant, and in the models for the middle age group, the interaction term for the middle education tercile remains positive and significant. Thus, even the use of relative education groups does not completely wipe out the trends. The estimates for the youngest age group are similar regardless the method used to measure education.

TABLE 5 ABOUT HERE ----- Regressions with education terciles

DISCUSSION AND CONCLUSION

The results of this study corroborate the well-known finding that education is strongly associated with health. I focus on the association between education and a simple measure of self-reported health, but the association holds for many other health measures as well. The descriptive results show evidence of large differences in self-reported health between education groups for all age groups and across the entire period 1982 to 2003, with the probability of reporting fair or poor health (as opposed to good, very good, or excellent health) up to 9 percentage points lower for college graduates than for high school graduates, and up to 30 percentage points lower for college graduates than for people without college degrees. Such differences are comparable to and in some cases greater than the differences between age groups.

In addition, new findings show that educational differences in self-reported health have also *increased* since the early 1980s, at least for adults ages 70 and over. Educational differences in health for younger adults, by contrast, have remained stable or even contracted. The finding of increasing health differences for older adults is not an artifact of the specific health measure I used, as other recent studies report similar

results for alternative measures of health (e.g., Schoeni et al. forthcoming). Though the finding that trends vary by age group is new, it is not astonishingly in light of what prior research shows about the patterning of educational differences in health by life-course stage. In particular, because older adults are the only age group for which health problems are common across all education levels, it makes sense that a trend toward increasing educational differences in health would occur primarily among this group.

Also new is the finding that these trends do not merely reflect change in the basic social and demographic composition of education groups. Average education levels continue to increase in the United States, as older, less-educated cohorts are replaced in the population by younger, more-educated cohorts. This trend could bias estimates of health trends by education level to the extent that such changes in population composition are also related to health. Life expectancy also continues to increase, adding a further source of compositional change. My regression results, however, show that the two main trends—increasing educational differences in health for older adults, stable or contracting differences for younger adults—hold up after adjusting for age and other social and demographic control variables. A second test— the use of relative as opposed to fixed education groups—shows relatively stronger effects of compositional change, though still not enough to overshadow the two main trends.

The findings are mixed news for the growing number of health policy makers and researchers wishing to eliminate or greatly reducing disparities in health between different segments of the U.S. population. On the positive side, educational differences in health are clearly not increasing across the board, and the trend toward narrowing

health differences for younger adults is particularly encouraging. On the negative side, however, evidence of increasing health differences for older adults is much more distressing, especially since this is the age group for which health problems are most common. The findings also complicate descriptions of recent inequality trends in the United States, in that the last decades of the twentieth century were not a period of increasing educational differences in health across all age groups. Rather, what emerges is a more complicated story in which lower education groups slowly catch up in health at younger ages, but only while at older ages higher education groups continue to pull ahead. Everyone may be moving on the same path toward better health, but higher education groups clearly hold a decided lead.

The great and important challenge for future research in this area is to uncover the factors behind the apparent changing association between education and health. Prior research on the social determinants of health has made significant progress in identifying the mechanisms or pathways linking education to health in a single cohort or at a single point in time. Asking why the strength of the association between education and health varies *between* cohorts or *across* time, however, is a slightly different question requiring different sets of answers. The results of this study are consistent with the predictions of several plausible stories, including (1) that college graduates have achieved relatively greater gains in health at older age through either their better access to or knowledge of new health services and medical technologies; (2) that the relative and absolute gains made by college graduates in such health-promoting behaviors as smoking cessation, increased exercise, and improved diet have been successful in pushing back the onset of health problems to a relatively short period toward the very

end of life; or (3) that the increasing disparities in material resources and wealth produced by the economic boom and stock market run up of the 1990s has had immediate short-term consequences for educational differences in health among older adults. A complete solution to this puzzle, however, will require more in-depth analyses of both repeated cross-sectional and longitudinal data, and must explain both why the association between education and health has changed over time, and why the nature of the trends has varied systematically by age group.

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Table 1. Percentage of Respondents Reporting Fair or Poor Health by Education Level, Age Group, and Survey Year.

| Age Group | Year | Education Level | | | All Education Levels |
		< 12 Years	12-15 Years	16+ Years	
70+	1983	40.4	26.4	22.8	34.2
	1988	39.4	23.8	18.2	31.0
	1993	37.9	24.9	19.2	29.6
	1998	39.4	22.9	13.8	28.0
	2003	39.3	23.0	16.1	27.0
50-69	1983	39.4	17.6	8.2	24.2
	1988	35.7	16.1	8.4	20.8
	1993	38.5	16.6	8.5	20.6
	1998	35.4	14.4	6.2	17.2
	2003	36.3	16.1	7.1	17.4
30-49	1983	22.3	7.2	2.4	8.9
	1988	20.0	6.8	2.6	7.6
	1993	21.4	8.5	3.1	8.7
	1998	17.3	7.0	2.5	7.3
	2003	17.2	8.0	3.0	8.0

Source: National Health Interview Survey (NHIS), respondents ages 30 and over.

Table 2. Differences in Self-Reported Health between Education Groups by Age and Survey Year.

		Percentage-Point Difference			Odds Ratio		
Age Group	Year	<12 Years versus 16+ Years	12-15 Years versus 16+ Years	<12 Years versus 12-15 Years	<12 Years versus 16+ Years	12-15 Years versus 16+ Years	<12 Years versus 12-15 Years
70+	1983	17.6	3.6	14.0	2.30	1.22	1.89
	1988	21.3	5.6	15.6	2.93	1.41	2.09
	1993	18.7	5.6	13.1	2.57	1.39	1.85
	1998	25.6	9.2	16.5	4.07	1.86	2.18
	2003	23.3	6.9	16.4	3.39	1.56	2.17
50-69	1983	31.2	9.4	21.8	7.26	2.38	3.05
	1988	27.3	7.7	19.6	6.08	2.10	2.89
	1993	30.0	8.0	21.9	6.72	2.13	3.15
	1998	29.2	8.1	21.1	8.27	2.52	3.27
	2003	29.2	9.1	20.1	7.50	2.53	2.96
30-49	1983	20.0	4.8	15.1	11.90	3.21	3.71
	1988	17.4	4.3	13.2	9.44	2.77	3.41
	1993	18.3	5.4	12.9	8.57	2.92	2.94
	1998	14.8	4.6	10.3	8.19	2.96	2.76
	2003	14.2	5.0	9.2	6.76	2.83	2.39

Source: National Health Interview Survey (NHIS), respondents age 30 and over.

Table 3. Selected Coefficients from Binary Logistic Regression Models of Self-Reported Health on Education Level, Survey Year, and Education Level × Survey Year Interaction.

Age Group	Independent Variable	Unadjusted		Adjusted	
		b	SE	b	SE
70+	Education: <12	.849***	(.043)	.805***	(.043)
	Education: 12-15	.225***	(.045)	.274***	(.045)
	Year	-.023***	(.003)	-.026***	(.003)
	Year × <12	.020***	(.003)	.020***	(.003)
	Year × 12-15	.015***	(.004)	.014***	(.004)
50-69	Education: <12	1.825***	(.033)	1.695***	(.033)
	Education: 12-15	.710***	(.033)	.710***	(.033)
	Year	-.019***	(.003)	-.020***	(.003)
	Year × <12	.015***	(.003)	.012***	(.003)
	Year × 12-15	.015***	(.003)	.012***	(.003)
30-49	Education: <12	2.410***	(.037)	2.233***	(.038)
	Education: 12-15	1.060***	(.036)	1.025***	(.036)
	Year	.015***	(.003)	.008**	(.003)
	Year × <12	-.021***	(.003)	-.015***	(.003)
	Year × 12-15	.001	(.003)	-.001	(.003)

Note: Numbers in parentheses are robust standard errors. Adjusted models add controls for gender, race, age, marital status, geographic region, and post-1996 survey year. Models were run separately for each age group. The reference group for education level is 16 or more years of formal schooling completed.

* $p < .05$ ** $p < .01$ *** $p < .001$ (two-tailed tests)

Table 4. Selected Coefficients from Linear Probability Models of Self-Reported Health on Education Level, Survey Year, and Education Level × Survey Year Interaction.

Age Group	Independent Variable	Unadjusted		Adjusted	
		b	SE	b	SE
70+	Education: <12	17.722***	(.728)	16.584***	(.724)
	Education: 12-15	4.192***	(.734)	5.129***	(.731)
	Year	-.364***	(.054)	-.409***	(.054)
	Year × <12	.301***	(.057)	.291***	(.056)
	Year × 12-15	.207***	(.055)	.181**	(.055)
50-69	Education: <12	29.137***	(.361)	26.603***	(.360)
	Education: 12-15	7.844***	(.283)	7.709***	(.284)
	Year	-.132***	(.022)	-.153***	(.022)
	Year × <12	.046	(.031)	.004	(.031)
	Year × 12-15	.079***	(.022)	.039	(.022)
30-49	Education: <12	19.775***	(.279)	18.122***	(.276)
	Education: 12-15	4.467***	(.122)	4.121***	(.123)
	Year	.077***	(.010)	.021*	(.010)
	Year × <12	-.227***	(.023)	-.181***	(.023)
	Year × 12-15	.034**	(.010)	.022*	(.010)

Note: Numbers in parentheses are robust standard errors. Adjusted models add controls for gender, race, age, marital status, geographic region, and post-1997 survey year. Models were run separately for each age group. The reference group for education level is 16 or more years of formal schooling completed.

* $p < .05$ ** $p < .01$ *** $p < .001$ (two-tailed tests)

Table 5. Selected Coefficients from Binary Logistic Regression Models of Self-Reported Health on Education Tercile, Survey Year, and Education Tercile × Survey Year Interaction.

Age Group	Independent Variable	Unadjusted		Adjusted	
		b	SE	b	SE
70+	Education: Bottom 3rd	.835***	(.027)	.724***	(.028)
	Education: Middle 3rd	.367***	(.028)	.356***	(.028)
	Year	-.021***	(.002)	-.025***	(.002)
	Year × Bottom 3rd	.010***	(.002)	.013***	(.002)
	Year × Middle 3rd	.001	(.002)	.002	(.002)
50-69	Education: Bottom 3rd	1.458***	(.021)	1.317***	(.021)
	Education: Middle 3rd	.414***	(.023)	.420***	(.023)
	Year	-.026***	(.002)	-.028***	(.002)
	Year × Bottom 3rd	.001	(.002)	.001	(.002)
	Year × Middle 3rd	.016***	(.002)	.014***	(.002)
30-49	Education: Bottom 3rd	1.689***	(.029)	1.575***	(.029)
	Education: Middle 3rd	.867***	(.031)	.834***	(.032)
	Year	.014***	(.002)	.006*	(.002)
	Year × Bottom 3rd	-.019***	(.002)	-.016***	(.002)
	Year × Middle 3rd	-.005	(.003)	-.006*	(.003)

Note: Numbers in parentheses are robust standard errors. Adjusted models add controls for gender, race, age, marital status, geographic region, and post-1997 survey year. Models were run separately for each age group. The reference group for education level is 16 or more years of formal schooling completed.

* $p < .05$ ** $p < .01$ *** $p < .001$ (two-tailed tests)

Figure 1. Predicted Probabilities of Reporting Fair or Poor Health by Education Level, Age Group, and Survey Year.