An Education Gradient in Health or a Health Gradient in Education? Education and Self-Rated Health from Age 15 to Age 31

by

Jamie L. Lynch Ph.D.
Department of Sociology
St. Norbert College
Boyle Hall 404
100 Grant Street
De Pere, WI 54115
Jamie.lynch@snc.edu

Paul T. von Hippel, Ph.D.
LBJ School of Public Affairs
University of Texas at Austin
2315 Red River, Box Y
Austin, TX 78712
paulvonhippel@utaustin.gmail.com

5406 words, 3 Tables, 4 Figures

Short title: Education gradient or health gradient?

Abstract

There is a positive gradient relating educational attainment and health, yet the causal direction of the gradient is not clear. Does higher education improve health—an education gradient in health. Or do the healthy become highly educated—a health gradient in education? This study addresses the direction of the gradient by tracking changes in educational attainment and self-rated health (SRH) from age 15 to age 31 in the National Longitudinal Study of Youth, 1997 cohort (NLSY97). Ordinal logistic regression shows that high-SRH adolescents are more likely to become highly educated, partly but not entirely because adolescent SRH is associated with adolescents' academic performance, college plans, and family background. Fixed-effects longitudinal regression shows that changes in educational attainment have little effect on SRH at age 31. Completion of a high school diploma has no effect on SRH at age 31, while completion of an associates, bachelors, or graduate degree have effects that, though significant, are quite small (less than 0.1 points on a 5-point scale). While it is possible that educational attainment would have greater effect on health at older ages, at age 31 what we see is primarily a health gradient in education, not an education gradient in health.

Introduction

More educated adults enjoy better health. At every age, adults with higher degrees or more years of education have fewer health risk factors, lower incidence of disease, and lower mortality (Cutler and Lleras-Muney 2008; Mirowsky and Ross 2003). Overall, more educated adults are more likely to rate their health as "excellent" or "very good" rather than "fair" or "poor" (Bauldry 2014). This association is widely known as the *education gradient in health*, a label makes health the dependent variable, implying that that education has a causal effect on health.

While the notion of an education gradient in health is familiar, from a different perspective the same gradient can be interpreted as a *health gradient in education*. This phrase implies that health and its correlates are predictive of educational attainment. Children and adolescents with better health tend to persist longer in school, complete more advanced degrees, and become more-educated adults (Palloni 2006).

It is of course possible that the gradient flows both ways, in which case we would have a story of cumulative advantage. Healthier children and adolescents would become more educated, and their education would make them even healthier relative to their less-educated peers. In that case, what we observe in adulthood would be partly a health gradient in education and partly an education gradient in health—perhaps best described by a direction-neutral term such as the *education-health gradient* (Conti, Heckman, and Urzua 2010) or perhaps the *health-education gradient*. In the remainder of this paper, we call it simply *the gradient*.

It is important for several reasons to understand the direction of the gradient. First, the direction of the gradient is fundamental to understanding aspects of social stratification, helping to clarify whether health is stratified by education or whether education is stratified by health. Second, the direction of the gradient is fundamental to evaluating the promise of social programs

that are designed to reduce inequalities in health or educational opportunity. If what we have is primarily a health gradient in education, then programs designed to improve the health of poor children—such as nurse home visits or expansions of public and subsidized health insurance—might be expected not just to improve health but to substantially improve academic performance and persistence (Campbell et al. 2014; Case, Fertig, and Paxson 2005). On the other hand, if what we have is primarily an education gradient in health, then programs that encourage high school and college completion—such as tuition subsidies and early warning systems that identify students at risk of dropout—might be expected not just to improve human capital but to improve population health and reduce the cost and burden of chronic disease.

In this article, we review theoretical mechanisms that might lead to either a health gradient in education or an education gradient in health. We then review the empirical evidence on the gradient, and assess the promise of different research designs in evaluating the gradient's direction. Finally, we carry out a new longitudinal study which tracks changes in educational attainment and self-rated health from age 15 to age 31.

Our longitudinal study finds that at age 31 nearly all of the gradient is due to the higher educational attainment of healthier adolescents, rather than the effect of higher education on adult health. What young adults display is primarily a health gradient in education rather than an education gradient in health.

Theoretical Mechanisms

The education gradient in health

Research arguing for an education gradient in health is often motivated by causal theories holding that higher educational attainment helps to maintain and improve health through several

mechanisms. In sociology, perhaps the leading causal theory distinguishes between economic, social-psychological, and lifestyle mechanisms through which educational attainment can limit health insults and improve health-seeking behavior (Ross and Wu 1995). Under the economic mechanism, higher education leads recipients away from the health risks and dangers associated with low-skill occupations (such as mining or construction), and into work that is relatively safe, stable, low stress, subjectively fulfilling, and high paying (Mirowsky and Ross 2003). According to the social-psychological mechanism, higher education increases perceived and experienced social support, which serve as a buffer against health insults (Thoits 1995), and higher education also increases "learned effectiveness," or the direct social-psychological behavioral mechanisms that allow adults to successfully navigate potential health setbacks without being disarmed by stress or poor coping skills (Mirowsky and Ross 2003).

In addition to preventing poor health, a central mechanism by which higher education might improve health is "health lifestyle." More-educated adults are more likely to engage in healthy behaviors, such as exercise, and less likely to engage in unhealthy behaviors, such as smoking (Ross and Wu 1995). The theorized effect of education on health lifestyle is attributed partly to increased personal control (Ross and Wu 1995) and partly to education's equipping adults with a better understanding of the health consequences of their behavior (Nayga 2000).

Outside of sociology, different causal mechanisms are used to argue for an education gradient in health. Physicians and economists are more likely to emphasize the role of the medical delivery system, pointing out that more-educated adults have more and better health insurance (Andrulis 1998), have higher-quality doctor's visits (Fiscella et al. 2000), and make greater use of advanced medical technology (Lleras-Muney and Lichtenberg 2002). It has also been suggested that higher education tends to increase future orientation, perhaps by increasing

income and the prospects for a comfortable old age; future orientation in turn it theorized to increase investments in long-term health (Becker and Mulligan 1997).

The health gradient in education

While the idea of an education gradient in health is perhaps the most common perspective in social research, an emerging counter-perspective argues that the gradient is at least partially a health gradient in education. Starting quite early in the life course, health and its correlates affect educational development and attainment (Conti et al. 2010). Some accounts of the health gradient in education claim that health affects educational attainment by delaying cognitive development (Hack, Klein, and Taylor 1995; Lynch 2011) and by limiting participation in schooling. For example, children and adolescents with poor health, including low birth weight and poor self-rated health, attend school less regularly, earn lower grades, more frequently drop out of high school or college, and commonly fail to reach as high a level of education as their healthier counterparts (Conley and Bennett 2000; Haas 2007; Jackson et al. 2006; Needham, Crosnoe, and Muller 2004). In support of this perspective, an encompassing review of chronic health problems and student performance found that infrequent school attendance and low academic achievement have a close association with a variety of chronic health conditions (Taras and Potts-Datema 2005).

A second explanation for the health gradient in education is that poor adolescent health negatively affects students' mental health and interactions with peers and teachers, resulting in poor evaluations, social isolation, and disengagement from school (Crosnoe 2007; Crosnoe and Muller 2004; Haas and Fosse 2008; Mustillo et al. 2003; Needham et al. 2004).

Another mechanism, emphasized in economics, is that good health increases subjective life expectancy, which can increase future orientation and make individuals more receptive to

long-term investments such as higher education (Becker and Mulligan 1997; Cutler and Lleras-Muney 2008; Steinberg et al. 2009). In the extreme, an adolescent diagnosed with a life-threatening chronic illness might see little point in spending much of their remaining time in school.

While health could have a causal effect on educational attainment, the higher educational attainment of healthier individuals could also be due to confounding advantages associated with social background. Advantages may be social or economic; for example, having wealthy or highly educated parents is predictive of good health, strong cognitive skills, and high educational attainment (Hayward and Gorman 2004; Orr 2003), while childhood disadvantage is associated with cognitive limitations (Sirin 2005) and health problems (Gorman 1999; Lynch 2011; Palloni 2006). From this perspective, the association between health and education is in place early in childhood, or even before birth, and persists throughout the life course and into future generations.

Rather than being consequences of health or education, psychological characteristics such as future orientation may also be causes in their own right. Early differences in future orientation, either learned or innate, may affect willingness both to pursue higher education and to maintain or improve health (Conti et al. 2010). Other psychological strengths may also affect both education and health; for example, both good health and high educational attainment are predicted by intelligence (Gottfredson 2004), by personality traits such as conscientiousness, agreeableness, and extraversion, and by non-cognitive skills such as motivation, self-control, and the ability to delay gratification (Palermo and Dowd 2012). To some degree these psychological traits are associated with family background, but psychological traits also have an independent effect which helps to explain why some children rise above or fall below the station of their parents (Roberts et al. 2007).

Notice that some of these accounts offer alternative explanations for the healthier behaviors of highly educated adults. Rather than being an effect of education, healthy behavior could be a sign of advantaged upbringing, or a consequence of a future orientation that also leads adults to complete higher education.

Research designs

Social scientists have employed a variety of research designs to investigate the gradient relating health to education. Studies looking for an education gradient in health frequently examine the association between educational attainment and health outcomes in adulthood, while studies looking for a health gradient in education often investigate the role of early health insults in predicting or shaping future educational attainment. Below we review the research designs associated with both approaches, then describe our own design.

Adult studies and the education gradient in health

Some studies, motivated by the idea of an education gradient in health, focus on adults. These studies use path analysis to regress adult health outcomes on adult educational attainment, with mediating paths to illustrate how the effect of educational attainment on health might be mediated by variables such as resources (e.g., income, health insurance), health behaviors (e.g., smoking, exercise), or psychological strengths (e.g., sense of control) (Mirowsky and Ross 2003).

The weakness of such designs is that the direction of causality is assumed rather than demonstrated. Drawing a path from educational attainment to health does not ensure that that is the direction in which causality actually flows. One could easily reverse the path and argue that adult health—or rather its precursors in adolescence—affects educational attainment.

This causal ambiguity is especially evident in cross-sectional studies, where the temporal order—did education precede health or did health precede education?—cannot be determined. Longitudinal studies begin to address this issue, but only if they stretch back to adolescence or childhood so that we can observe individuals' health outcomes before they became highly educated. Unfortunately, much longitudinal research on the gradient begins in middle age or later, so that over the years of the study we can only observe changes in health, not changes in educational attainment (Lantz et al. 2001; Ross and Mirowsky 1999). The question of causal ordering remains unresolved.

Some adult studies incorporate control variables (such as race and gender) into a model that uses educational attainment to predict adult health. These control variables can be used in a regression model (Adler et al. 1994; Kimbro et al. 2008; Mirowsky and Ross 2003; Ross and Wu 1995), or they can be used to construct propensity scores on which more- and less-educated adults are matched (Schafer, Wilkinson, and Ferraro 2013). It is not clear, however, how much the use of observed control variables accomplishes. In our own analyses, below, we find that even a long list of control variables is not adequate to explain the higher educational attainment of healthier adolescents. It is therefore questionable whether controlling for these same variables is adequate to correct for preexisting health differences between more and less educated adults. If preexisting differences are present, then some adult studies likely overestimate the causal effect of educational attainment on health. The effects of potential mediators may be biased as well.

An alternative to control variables is to examine health differences and education differences between siblings or twins (see Lundborg 2012 for an example). Twin and sibling models make within-family comparisons that hold constant unobserved factors that are shared within families. Sibling studies models typically find that there is a health gradient in education; that is, child and adolescent health predict educational attainment (Conley and Bennett 2000;

Haas and Fosse 2008; Jackson 2009). However, sibling studies do not necessarily support the idea of a strong educational gradient in health. Some sibling studies have found that the effect of educational attainment on adult health is small (Kemptner, Jürges, and Reinhold 2011) and sometimes nonsignificant (Haas 2006).

Another approach to estimating education's effect on health is to find an instrumental variable, such as a change in compulsory schooling laws, which affects educational attainment without affecting health through any other path. Studies using instrumental variables have arrived at mixed conclusions. One instrumental variable study found that the effect of educational attainment on self-rated health was small or insignificant (Arendt 2005), but another instrumental variable study found a large and significant effect (Silles 2009).

Adolescent studies and the health gradient in education

Unlike studies of the education gradient in health, studies of the health gradient in education commonly begin in adolescence. Well before education is complete, substantial health gaps exist between adolescents who will and will not complete higher levels of education, so that measures of adolescent health—including self-rated health (Haas and Fosse 2008; Jackson 2009)—can be used to predict educational attainment. However, many adolescent studies do not follow their subjects into adulthood and so cannot examine whether the health-education narrows, expands, or remains stable after educational attainment is complete.

Our approach

In our study, we start with adolescents (age 15) but we follow them until age 31. By observing their self-rated health both before and after their education is complete, we are able to assess the education gradient in health with a rigor that is rarely possible in studies that begin after education is complete, or in studies that stop as soon as education is complete.

We use adolescent self-rated health to predict adult educational attainment; this is our estimate of the health gradient in education. We then use a fixed effects model to estimate the effect of changes in educational attainment on changes in self-rated health; this is our estimate of the education gradient in health. A similar approach has previously been used to clarify the causal relationship between education and body mass index (von Hippel and Lynch 2014).

Data

We analyze the 1997 cohort of the National Longitudinal Survey of Youth (NLSY97), a nationally representative probability sample of all American youth supplemented by oversamples of blacks and Hispanics. The NLSY97 is a longitudinal study of 8,984 participants who were 12 to 18 years old on December 31, 1996 and then interviewed every year from 1997 until 2011, so that the youngest participants were followed from ages 12 to 26 and the oldest participants were followed from ages 18 to 32. By multiply imputing longitudinal variables[1], we obtain a balanced panel that runs from age 15 to age 31.

Key variables

Our key longitudinal variables are educational attainment and self-rated health (SRH). We define educational attainment as an ordinal variable with five levels: (1) high school not completed (yet), (2) high school diploma or GED completed, (3) associate's degree completed, (4) bachelor's degree completed, and (5) graduate degree completed.

[1] To impute missing values, we reshaped the longitudinal data into wide format, so that all the information available on a given respondent was summarized in a single row, with SRH and educational attainment at age 15, 16, etc. recorded in separate columns, one column for each variable and age (Allison 2001). The reshaped data was imputed ten times using the *mi impute chained* command in Stata 12, in which each variable is imputed by iteratively regressing it on all the other variables. Ordinal regression models were used to impute educational attainment and SRH, while normal regression models were used to impute continuous variables.

Figure 1a presents a stacked bar chart that summarizes how the distribution of educational attainment in the NLSY97 changes from age 15 to age 31. As expected, the percentage of respondents with higher degrees increases as respondents get older. The bulk of high school diplomas are completed by age 19; the bulk of associate's degrees are completed by age 23; the bulk of bachelor's degrees are completed by age 25; and completion of graduate degrees slows by age 29. What this means is the data offer about 13 years of follow-up to estimate the effect of a high school diploma, 10 years to estimate the effect of an associate's degree, 6 years to estimate the effect of a bachelor's degree, and just 2 years to estimate the effect of a graduate degree. Figure 1a also shows that many more respondents finish bachelor's degrees than associates or graduate degrees. Considering both sample size and length of followup, our power is greatest for detecting the effect of a high school diploma, and perhaps next-greatest for detecting the effect of a bachelor's degree.

Our other key variable is self-rated health (SRH), defined as respondent's answer to the question "In general, how is your health?" SRH is an ordinal variable with five levels[2]: (1) Poor, (2) Fair, (3) Good, (4) Very Good, and (5) Excellent. Although SRH is less informative than a comprehensive health exam, it is a global measure and more informative than almost any individual health measure such as BMI or blood pressure (Jylhä 2009). Although somewhat subjective and just 55% reliable (Boardman 2006), SRH is correlated with a variety of chronic health conditions and health risk factors (Singh-Manoux et al. 2006), as well as functional and emotional conditions that are difficult to assess by exam or questionnaire, but are observable to respondents—such as susceptibility to infection, aches, depression, and fatigue (Jylhä 2009). SRH is a strong predictor of future illness, debility, and mortality (Ferraro and Farmer 1999;

[2] In the survey data, poor is coded as 5 and excellent is coded as 1. We reversed the numerical coding so that larger numbers represent better health.

Idler and Benyamini 1997) and a good predictor of educational attainment (Haas and Fosse 2008; Jackson 2009), as our results will confirm.

Figure 1b presents a stacked bar chart that summarizes how the distribution of SRH changes from age 15 to age 31. The vast majority of young respondents describe their health as either good (3), very good (4) or excellent (5) in all years of the survey, but there is a gradual decline with age, as the modal category shifts from excellent to very good health and the lower categories grow as well.

Covariates

Both educational attainment and SRH are correlated with a number of other variables that will be important to control in certain analyses. To describe respondents' family of origin, we used race/ethnicity, mother's and father's educational attainment, family income and wealth at the start of the survey in 1997, and number of parents in the home when the respondents was 17 years old. To measure intelligence and ability, we used the respondent's score on the Armed Services Vocational Aptitude Battery (ASVAB), a job-placement test which has a about .8 correlation with IQ test scores (McGrevy and Others 1974). NLSY97 respondents took the ASVAB in the first wave of the NLSY97, when they were aged 12 to 16; scores were converted by NLSY97 staff to an age-specific percentile. To measure academic achievement, we used the respondent's high school grade point average (GPA, with a possible range of 0-4.0).

Several additional variables that could be associated with both health and educational attainment were also included. To measure school engagement, we included measures of peer school engagement, as reported by the respondent: the proportion of peers likely to attend college or regularly skip class (measured 1 to 5, where 1 = almost none and 5 = almost all). Given that social-psychological factors might be correlated with perceived health and

educational attainment, we included a number of variables measuring whether the respondent was bullied in childhood; whether the respondent often lies or cheats; and whether the youth is often depressed. Additional potential confounders include respondent's answers to several questions about future orientation. At age 17, respondents are asked to assess their probability of dying by age 20, becoming a parent, or graduating high school by age 20, and of earning a college degree and working more than 20 hours a week by age 30. Pessimistic answers to these questions may be viewed as reflecting a poor future orientation.

Table 1 summarizes the covariates used in the analyses, giving their means, standard deviations, and correlations with SRH.

←Table 1 near here→

Methods

To estimate the health gradient in education, we fit ordinal logistic regressions in which SRH at age 17 was used to predict the highest degree obtained by age 31. The regressions were fit both with and without covariates including family structure and parents' education, income, family wealth, ASVAB scores, high school GPA, self and peer school engagement, social-psychological factors, and race/ethnicity. The models that we present use SRH at age 17 as a linear predictor. Similar but less easily interpreted results were obtained if we broke SRH into a set of dummy variables.

To estimate the education gradient in health, we contrast two approaches, one naïve and one sophisticated. The naïve approach regresses SRH on educational attainment at age 31, with no covariates. Although common enough, this approach cannot clarify whether we are looking at an education gradient in health or a health gradient in education or.

A more sophisticated approach regresses time-varying measures of SRH, from age 15 to age 31, on individual fixed effects and time-varying measures of educational attainment, coded as a series of dummy variables that turn from 0 to 1 in the year when respondents achieve (1) a high school diploma, (2) an associate's degree, (3) a bachelor's degree, or (4) a graduate degree. This fixed-effects model comes closer than the naïve regression model to estimating the true causal effect of educational attainment on SRH. A fixed effect model is better than simply adding control variables to a regression, because the fixed effects control not only for observed confounders, but also for unobserved confounders provided they do not change with age (Allison 2009). In addition, the fixed effects absorb some idiosyncrasies in the way that different respondents use the SRH scale. For example, between two respondents with identical objective health, one may describe their health as merely "very good" while the other describes it as "excellent." The rose-tinted perspective of the second respondent will be absorbed in their fixed effect, provided their perspective does not darken as they grow older.

Since fixed-effects models do not control for time-varying confounders, our analyses include dummy variables for every age from 15 to 30 (omitting age 31). These age dummies adjust for the general downtrend in SRH as respondents grow older. Controlling for this downtrend is important because age is confounded with educational attainment.

In sum the model is

$$SRH_{it} = \mu + \beta_{0i} + \beta_1 educ_{it} + \beta_2 age_{it} + u_{it}$$

where SRH_{it} is the self-rated health of individual *i* at wave *t* of the survey. The intercept μ is the average value of SRH for 31-year-old high-school dropouts. β_{0i} are the individual fixed effects, constrained to have an average of 0. β_1 is a vector containing the coefficients of $educ_{it}$, which is a vector of 4 dummy variables representing completion of levels of education ranging from a high school diploma/GED to a graduate degree (high school noncompleters are the omitted

category). β_2 is a vector containing the coefficients of age_{it} which is a vector of dummy variables for each age from 15 to 30 (31 is the omitted category). Finally, u_{it} is a random residual assumed to be independent of other variables and internally uncorrelated. We also fit a variant of the model in which u_{it} was autocorrelated with an AR(1) structure. The results were practically identical and are omitted to save space.

Results

Figure 2 shows what we call the "health gradient in education." For each level of SRH at age 17, the figure gives a stacked bar chart showing what percentage of respondents complete lower and higher degrees of education by age 31. The figure shows graphically that there is a strong tendency for healthier adolescents to become more highly educated. For example, adolescents with excellent SRH are more than twice as likely to complete at least a bachelor's degree than are adolescents with fair or poor SRH (38% vs. 15%).

Table 2 models the health gradient in education more formally by fitting an ordinal logistic regression that uses SRH at age 17 to predict five levels of educational attainment at age 31. The baseline estimates in Model 1 confirm that healthy adolescents tend to become more highly educated. A one-unit increase in SRH predicts a 38% increase in the odds of earning a higher degree.

Table 2 shows that about half of the health gradient in education can be explained by control variables, especially family background, ASVAB score, GPA, and the self-assessed probability of completing high school, completing college, or becoming a teen parent. Net of these confounders, however, a one-point increase in SRH at age 17 still predicts a 19% increase in the odds of earning a higher degree. The net predictive value of SRH could be explained by

omitted confounders, or it could indicate that SRH itself has a causal effect on educational attainment; for example, poor self-perceived health could limit respondents' future orientation, or could limit their energy to focus on schoolwork.

The results so far establish that there is a health gradient in education. How much does that affect our estimate of the education gradient in health? Table 3 addresses this question by showing, in parallel columns, (1) the estimates from an OLS regression of SRH on educational attainment at age 31, and (2) the estimates from a fixed-effects regression that uses changes in educational attainment to predict changes in SRH from age 15 to age 31.

Figure 3 summarizes the estimates graphically. The differences between the estimates are striking. The OLS estimates have a familiar stair-stepped appearance, with each educational level significantly healthier than the one below it. For example, 31-year-olds with a bachelor's degree have SRH that is 0.5 points higher, on average, than 31-year-olds who never completed high school. This is a large difference; it is equivalent to half the difference between good and very good health, or half the standard deviation of the SRH scale at age 31.

The fixed-effects estimates, by contrast, are relatively flat, with no significant SRH benefits to completing a high school diploma or GED. Completion of an associate's, bachelor's or graduate degree does significantly improve SRH according to the fixed effects model, but the improvement is just 0.04-0.08 points on the SRH scale—statistically significant, but less than a tenth of a standard deviation, and only about 15% of the corresponding OLS estimates.

Figure 4 summarizes the evolution of the gradient in a single graph, showing trends in SRH separately for respondents by educational attainment at age 31. At age 15, about 8 years before respondents typically finish college, adolescents who will eventually receive a bachelor's degree have higher average SRH than adolescents who will not. This gap grows by less than a tenth of a point over the next 16 years. On the whole, it appears that educational attainment does

little to modify the gradient that already exists before education is complete.

Conclusion

The results in this study suggest that what we observe at age 31 is primarily a health gradient in education, rather than an education gradient in health. In some ways this finding is not surprising. There is an established literature showing that healthier adolescents tend to become more highly educated (Crosnoe 2007; Gortmaker et al. 1993; Haas and Fosse 2008; von Hippel and Lynch 2014; Jackson 2009), and strong causal research designs commonly show that the benefits of education for health are considerably smaller than a simple regression of health on educational attainment would suggest (Conti et al. 2010; von Hippel and Lynch 2014; Lundborg 2012). However, many studies continue to regress adult health on adult educational attainment (Cundiff et al. 2013; Holmes and Zajacova 2014; Olshansky et al. 2012; Reagan and Salsberry 2014; Zajacova, Hummer, and Rogers 2012), without taking sufficient precautions to control for the health gradient that exists before education is complete. It seems plausible that these studies implicitly overestimate the education gradient in health because they neglect the health gradient in education.

A key limitation of our study is that it ends at age 31. In some respects this is an early end. Age 31 is just 2-3 years after graduate school and 2-3 decades before most adults show any sign of chronic illness or disability. In other respects, however, age 31 is not so early. Self-rated health has noticeably declined by age 31; respondents half as likely to rate their health as "excellent" at age 31 as they are at age 15. While killers such as cancer and heart disease are rare at age 31, by age 31 a substantial number of adults have physical and mental health problems such as overweight, depression, fatigue, joint pain, headaches, heartburn, and other conditions

that, while not necessarily life-threatening, are predictive of worse problems to come, and noticeable enough to affect SRH (Goodman 1999). In addition, age 31 is 13 years after the typical high school graduation, and 10 years after the typical completion of an associate's degree. Followup periods of 10-13 years seem long enough to observe at least some small effects of education. It is rather striking that our fixed-effects analyses showed no health benefits at all of completing a high school diploma and only a .04 point effect of completing an associate's degree.

That said, it is plausible that the data limit our estimates by stopping at age 31. Some health effects of education are likely cumulative (Margolis 2013), and several of the mechanisms by which higher education is thought to affect health might not start to show their cumulative effects until adults reach middle age or later. This is an excellent subject for future research, especially given that previous studies have arrived at mixed conclusions regarding latter life health benefits to education. Indeed, one study found the health benefits of education to increase with age, particularly in modern cohorts (Lynch 2003), while a recent twin study found no causal effect of educational attainment on late-life hospitalization or mortality (Behrman et al. 2011). Any attempt to estimate the later-life education gradient in health must adequately control for the early-life health gradient in education.

References

Adler, Nancy E. et al. 1994. "Socioeconomic Status and Health: The Challenge of the Gradient." *American psychologist* 49(1):15.

Allison, Paul D. 2001. *Missing Data*. Thousand Oaks, CA: Sage.

Allison, Paul David. 2009. *Fixed Effects Regression Models*. Sage Los Angeles.

Andrulis, Dennis P. 1998. "Access to Care Is the Centerpiece in the Elimination of Socioeconomic Disparities in Health." *Annals of Internal Medicine* 129(5):412–16.

Arendt, Jacob Nielsen. 2005. "Does Education Cause Better Health? A Panel Data Analysis Using School Reforms for Identification." *Economics of Education Review* 24(2):149–60.

Averett, Susan L., Asia Sikora, and Laura M. Argys. 2008. "For Better or Worse: Relationship Status and Body Mass Index." *Economics and Human Biology* 6(3):330–49.

Bauldry, Shawn. 2014. "Conditional Health-Related Benefits of Higher Education: An Assessment of Compensatory versus Accumulative Mechanisms." *Social Science & Medicine* 111:94–100.

Becker, Gary S., and Casey B. Mulligan. 1997. "The Endogenous Determination of Time Preference." *The Quarterly Journal of Economics* 112(3):729–58.

Behrman, Jere R. et al. 2011. "Does More Schooling Reduce Hospitalization and Delay Mortality? New Evidence Based on Danish Twins." *Demography* 48(4):1347–75.

Boardman, Jason D. 2006. "Self-Rated Health among U.S. Adolescents." *The Journal of Adolescent Health* 38(4):401–8.

Campbell, Frances et al. 2014. "Early Childhood Investments Substantially Boost Adult Health." *Science* 343(6178):1478–85.

Case, Anne, Angela Fertig, and Christina Paxson. 2005. "The Lasting Impact of Childhood Health and Circumstance." *Journal of Health Economics* 24(2):365–89.

Conley, Dalton, and Neil G. Bennett. 2000. "Is Biology Destiny? Birth Weight and Life Chances." *American Sociological Review* 65(3):458–67.

Conti, Gabriella, James Heckman, and Sergio Urzua. 2010. "The Education-Health Gradient." *The American economic review* 100(2):234.

Crosnoe, Robert. 2007. "Gender, Obesity, and Education." *Sociology of Education* 80(3):241–60.

Crosnoe, Robert, and Chandra Muller. 2004. "Body Mass Index, Academic Achievement, and School Context: Examining the Educational Experiences of Adolescents at Risk of

Obesity." *Journal of Health and Social Behavior* 45(4):393–407.

Cundiff, Jenny M., Bert N. Uchino, Timothy W. Smith, and Wendy Birmingham. 2013. "Socioeconomic Status and Health: Education and Income Are Independent and Joint Predictors of Ambulatory Blood Pressure." *Journal of behavioral medicine* 1–8.

Cutler, David M., and Adriana Lleras-Muney. 2008. "Education and Health: Evaluating Theories and Evidence." in *Making Americans Healthier: Social and Economic Policy as Health Policy*. New York, NY: Sage.

Ferraro, Kenneth F., and Melissa M. Farmer. 1999. "Utility of Health Data from Social Surveys: Is There a Gold Standard for Measuring Morbidity?" *American Sociological Review* 64(2):303–15.

Fiscella, Kevin, Peter Franks, Marthe R. Gold, and Carolyn M. Clancy. 2000. "Inequality in Quality." *JAMA: The Journal of the American Medical Association* 283(19):2579–84.

Goodman, E. 1999. "The Role of Socioeconomic Status Gradients in Explaining Differences in US Adolescents' Health." *American Journal of Public Health* 89(10):1522–28.

Gorman, Bridget K. 1999. "Racial and Ethnic Variation in Low Birthweight in the United States: Individual and Contextual Determinants." *Health & Place* 5(3):195–207.

Gortmaker, Stephen L., A. Must, J. M. Perrin, A. M. Sobol, and William H. Dietz. 1993. "Social and Economic Consequences of Overweight in Adolescence and Young Adulthood." *The New England Journal of Medicine* 329(14):1008–12.

Gottfredson, Linda S. 2004. "Intelligence: Is It the Epidemiologists' Elusive 'Fundamental Cause' of Social Class Inequalities in Health?." *Journal of Personality and Social Psychology* 86(1):174–99.

Haas, Steven. 2007. "The Long-Term Effects of Poor Childhood Health: An Assessment and Application of Retrospective Reports." *Demography* 44(1):113–35 – 135.

Haas, Steven A. 2006. "Health Selection and the Process of Social Stratification: The Effect of Childhood Health on Socioeconomic Attainment." *Journal of Health and Social Behavior* 47(4):339–54.

Haas, Steven A., and Nathan Edward Fosse. 2008. "Health and the Educational Attainment of Adolescents: Evidence from the NLSY97." *Journal of Health and Social Behavior* 49(2):178–92.

Hack, Maureen, Nancy K. Klein, and H. Gerry Taylor. 1995. "Long-Term Developmental Outcomes of Low Birth Weight Infants." *The Future of Children* 5(1):176–96.

Hayward, Mark D., and Bridget K. Gorman. 2004. "The Long Arm of Childhood: The Influence of Early-Life Social Conditions on Men's Mortality." *Demography* 41(1):87–107.

Von Hippel, Paul T., and Jamie L. Lynch. 2014. "Why Are Educated Adults slim—Causation or

Selection?" *Social Science & Medicine* 105(3). Retrieved January 21, 2014 (http://www.sciencedirect.com/science/article/pii/S0277953614000264).

Holmes, Christopher J., and Anna Zajacova. 2014. "Education as 'the Great Equalizer': Health Benefits for Black and White Adults." *Social Science Quarterly*.

Idler, Ellen L., and Yael Benyamini. 1997. "Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies." *Journal of Health and Social Behavior* 38(1):21–37.

Jackson, J. Elizabeth, Mark P. Doescher, Anthony F. Jerant, and L. Gary Hart. 2006. "A National Study of Obesity Prevalence and Trends by Type of Rural County." *The Journal of Rural Health* 21(2):140–48.

Jackson, Margot. 2009. "Understanding Links between Adolescent Health and Educational Attainment." *Demography* 46(4):671–94.

Jylhä, Marja. 2009. "What Is Self-Rated Health and Why Does It Predict Mortality? Towards a Unified Conceptual Model." *Social science & medicine* 69(3):307–16.

Kemptner, Daniel, Hendrik Jürges, and Steffen Reinhold. 2011. "Changes in Compulsory Schooling and the Causal Effect of Education on Health: Evidence from Germany." *Journal of Health Economics* 30(2):340–54.

Kimbro, Rachel Tolbert, Sharon Bzostek, Noreen Goldman, and Germán Rodríguez. 2008. "Race, Ethnicity, and the Education Gradient in Health." *Health Affairs* 27(2):361–72.

Lantz, Paula M. et al. 2001. "Socioeconomic Disparities in Health Change in a Longitudinal Study of US Adults: The Role of Health-Risk Behaviors." *Social Science & Medicine* 53(1):29–40.

Lleras-Muney, Adriana, and Frank R. Lichtenberg. 2002. "The Effect of Education on Medical Technology Adoption: Are the More Educated More Likely to Use New Drugs." *NBER Working Paper* 9185. Retrieved (http://www.nber.org/papers/w9185).

Lundborg, Petter. 2012. "The Health Returns to Schooling—what Can We Learn from Twins?" *Journal of Population Economics* 1–29.

Lynch, Jamie L. 2011. "Infant Health, Race/Ethnicity, and Early Educational Outcomes Using the ECLS-B." *Sociological Inquiry* 81(4):499–526.

Lynch, Scott M. 2003. "Cohort and Life-Course Patterns in the Relationship between Education and Health: A Hierarchical Approach." *Demography* 40(2):309–31.

Margolis, Rachel. 2013. "Educational Differences in Healthy Behavior Changes and Adherence Among Middle-Aged Americans." *Journal of Health and Social Behavior* 54(3):353–68.

McGrevy, David F., and And Others. 1974. "Relationships Among an Individual Intelligence Test and Two Air Force Screening and Selection Tests." Retrieved July 14, 2014 (http://eric.ed.gov/?id=ED100981).

Mirowsky, John, and Catherine E. Ross. 2003. *Education, Social Status, and Health*. Hawthorne, NY: Aldine de Gruyter.

Mustillo, Sarah et al. 2003. "Obesity and Psychiatric Disorder: Developmental Trajectories." *Pediatrics* 111(4):851–59.

Nayga, Rodolfo M. 2000. "Schooling, Health Knowledge and Obesity." *Applied Economics* 32(7):815–22.

Needham, Belinda L., Robert Crosnoe, and Chandra Muller. 2004. "Academic Failure in Secondary School: The Inter-Related Role of Health Problems and Educational Context." *Social Problems* 51:569.

Olshansky, S. Jay et al. 2012. "Differences in Life Expectancy due to Race and Educational Differences Are Widening, and Many May Not Catch up." *Health Affairs* 31(8):1803–13.

Orr, Amy J. 2003. "Black-White Differences in Achievement: The Importance of Wealth." *Sociology of Education* 76(4):281–304.

Palermo, Tia M., and Jennifer B. Dowd. 2012. "Childhood Obesity and Human Capital Accumulation." *Social Science & Medicine* 75(11):1989–98.

Palloni, Alberto. 2006. "Reproducing Inequalities: Luck, Wallets, and the Enduring Effects of Childhood Health." *Demography* 43:587–615.

Reagan, Patricia B., and Pamela J. Salsberry. 2014. "Cross Race Comparisons between SES Health Gradients among African–American and White Women at Mid-Life." *Social Science & Medicine* 108(0):81–88.

Roberts, Brent W., Nathan R. Kuncel, Rebecca Shiner, Avshalom Caspi, and Lewis R. Goldberg. 2007. "The Power of Personality: The Comparative Validity of Personality Traits, Socioeconomic Status, and Cognitive Ability for Predicting Important Life Outcomes." *Perspectives on Psychological Science* 2(4):313–45.

Ross, Catherine E., and John Mirowsky. 1999. "Refining the Assocation between Education and Health: The Effects of Quantity, Credential, and Selectivity." *Demography* 36(4):445–60.

Ross, Catherine E., and Chia-ling Wu. 1995. "The Links Between Education and Health." *American Sociological Review* 60(5):719–45.

Schafer, Markus H., Lindsay R. Wilkinson, and Kenneth F. Ferraro. 2013. "Childhood (mis) Fortune, Educational Attainment, and Adult Health: Contingent Benefits of a College Degree?" *Social forces* sos192.

Silles, Mary A. 2009. "The Causal Effect of Education on Health: Evidence from the United Kingdom." *Economics of Education Review* 28(1):122–28.

Singh-Manoux, Archana et al. 2006. "What Does Self Rated Health Measure? Results from the British Whitehall II and French Gazel Cohort Studies." *Journal of Epidemiology and*

Community Health 60(4):364–72.

Sirin, Selcuk R. 2005. "Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research." *Review of Educational Research* 75(3):417–53.

Steinberg, Laurence et al. 2009. "Age Differences in Future Orientation and Delay Discounting." *Child Development* 80(1):28–44.

Taras, Howard, and William Potts-Datema. 2005. "Chronic Health Conditions and Student Performance at School." *Journal of School Health* 75(7):255–66.

Thoits, Peggy A. 1995. "Stress, Coping, and Social Support Processes: Where Are We? What Next?" *Journal of health and social behavior* 53–79.

Zajacova, Anna, Robert A. Hummer, and Richard G. Rogers. 2012. "Education and Health among U.S. Working-Age Adults: A Detailed Portrait across the Full Educational Attainment Spectrum." *Biodemography and Social Biology* 58(1):40–61.

Tables and Figures

Table 1. Descriptive Statistics, ten imputations (NLSY97)

	Mean	Standard Deviation	Correlation with Age 17 SRH
Self-rated Health age 17	4.043	0.922	
Self-rated Health age 31	3.604	0.996	0.295***
Poor Self-rated Health age 17	0.004		
Excellent Self-rated Health age 17	0.385		
Poor Self-rated Health age 31	0.021		-0.072*
Excellent Self-rated Health age 31	0.198		0.180***
White	0.496		0.025*
Black	0.260		0.010
Hispanic	0.212		-0.039***
Other	0.033		-0.005
Degree status age 31			
Less than high school	0.085		-0.089
High school diploma/GED	0.587		-0.078*
Associate's degree	0.047		-0.006
Bachelor's degree	0.202		0.119***
Graduate degree	0.079		0.084**
Mother's education			
Less than high school	0.240		-0.092
High school diploma/GED	0.367		0.003
Associate's degree	0.226		0.035**
Bachelor's degree	0.108		0.040***
Graduate degree	0.059		0.045***
Father's education			
Less than high school	0.256		-0.096
High school diploma/GED	0.386		-0.021+
Associate's degree	0.171		0.042***
Bachelor's degree	0.108		0.048***
Graduate degree	0.079		0.067***
Family Income/10k in 1997	4.569	4.204	0.111***
Family Wealth/10k in 1997	9.793	13.900	0.107***
Lives with both parents age 17	0.489	0.500	0.096***
ASVAB percentile	44.103	29.225	0.114***
Average High School Grades	2.771	0.811	0.129***
Friends plan to go college	3.568	1.076	0.082***
Friends regularly skip class	2.409	1.278	-0.065***
Victim of repeated bullying before age 12	0.194	0.396	-0.067***
Lies or cheats	0.517	0.500	-0.061***
Depressed	0.461	0.498	-0.082***
Percent chance to die by 20	19.389	22.584	-0.049***
Percent chance to be parent by 20	16.824	26.090	-0.073***
Percent chance high school graduate by 20	93.124	18.874	0.062***
Percent chance college degree by 30	73.616	31.688	0.092***
Percent chance to work 20+ hours by age 30	92.495	17.098	0.042***

$^{+}p<.10$, $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$

Table 2. Predicting educational attainment at age 31 by Self-rated Health at age 17

	Model 1	Model 2
Self-rated Health	1.375***	1.190***
	(0.038)	(0.036)
Race (ref=white)		
Black		1.244**
		(0.096)
Hispanic		0.980
		(0.076)
Other		1.536**
		(0.208)
Male (ref=female)		0.697***
		(0.038)
Mother's education		
High school diploma/GED		1.175+
		(0.103)
Associate's degree		1.495***
		(0.139)
Bachelor's degree		2.118***
		(0.232)
Graduate degree		2.242***
		(0.296)
Father's education		
High school diploma/GED		1.232*
		(0.112)
Associate's degree		1.293*
		(0.135)
Bachelor's degree		1.498**
		(0.172)
Graduate degree		1.636***
		(0.206)
Family Income/10k in 1997		1.017+
		(0.010)
Family Wealth/10k at first interview		1.004+
		(0.003)
ASVAB percentile		1.018***
		(0.001)
Lives with both parents age 17		1.460***
		(0.079)
Average High School Grades		2.032***
		(0.086)
Victim of repeated bullying before age 12		0.911
		(0.061)
Lies or cheats		1.005
		(0.068)
Depressed		0.936
		(0.062)
Friends plan to go college		1.087**
		(0.027)
Friends regularly skip class		0.993
		(0.022)
Percent chance to die by 20 /100		0.999
		(0.001)
Percent chance to be parent by 20 /100		0.998+
		(0.001)
Percent chance high school graduate by 20 /100		1.004*
		(0.002)

Percent chance college degree by 30 /100		1.003**
		(0.001)
Percent chance to work 20+ hours by age 30 /100		0.999
		(0.002)
Cut 1	-1.125	1.710
Cut 2	2.020	5.810
Cut 3	2.245	6.128
Cut 4	3.780	8.102

(Parentheses enclose standard errors). $^{+}p<.10$, $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

Table 3. Fixed-effect panel regression of self-rated health on educational attainment from age 15 to 31

Regressors		OLS	Fixed effects
Educational attainment	High school diploma	0.20***	-0.01
		(0.05)	(0.01)
	Associates degree	0.33***	0.04*
		(0.09)	(0.02)
	Bachelor's degree	0.51***	0.07***
		(0.06)	(0.02)
	Graduate degree	0.58***	0.08**
		(0.10)	(0.03)
Age			
(reference = age 31)	15		0.49***
			(0.03)
	16		0.45***
			(0.03)
	17		0.46***
			(0.02)
	18		0.40***
			(0.02)
	19		0.39***
			(0.02)
	20		0.34***
			(0.02)
	21		0.31***
			(0.03)
	22		0.31***
			(0.02)
	23		0.27***
			(0.02)
	24		0.24***
			(0.03)
	25		0.20***
			(0.03)
	26		0.19***
			(0.02)
	27		0.14***
			(0.02)
	28		0.11***
			(0.02)
	29		0.09***
			(0.02)
	30		0.04+
			(0.02)
	Constant	3.32***	3.59***
		(.06)	(0.02)

(Parentheses enclose standard errors). $^{+}p<.10$, $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

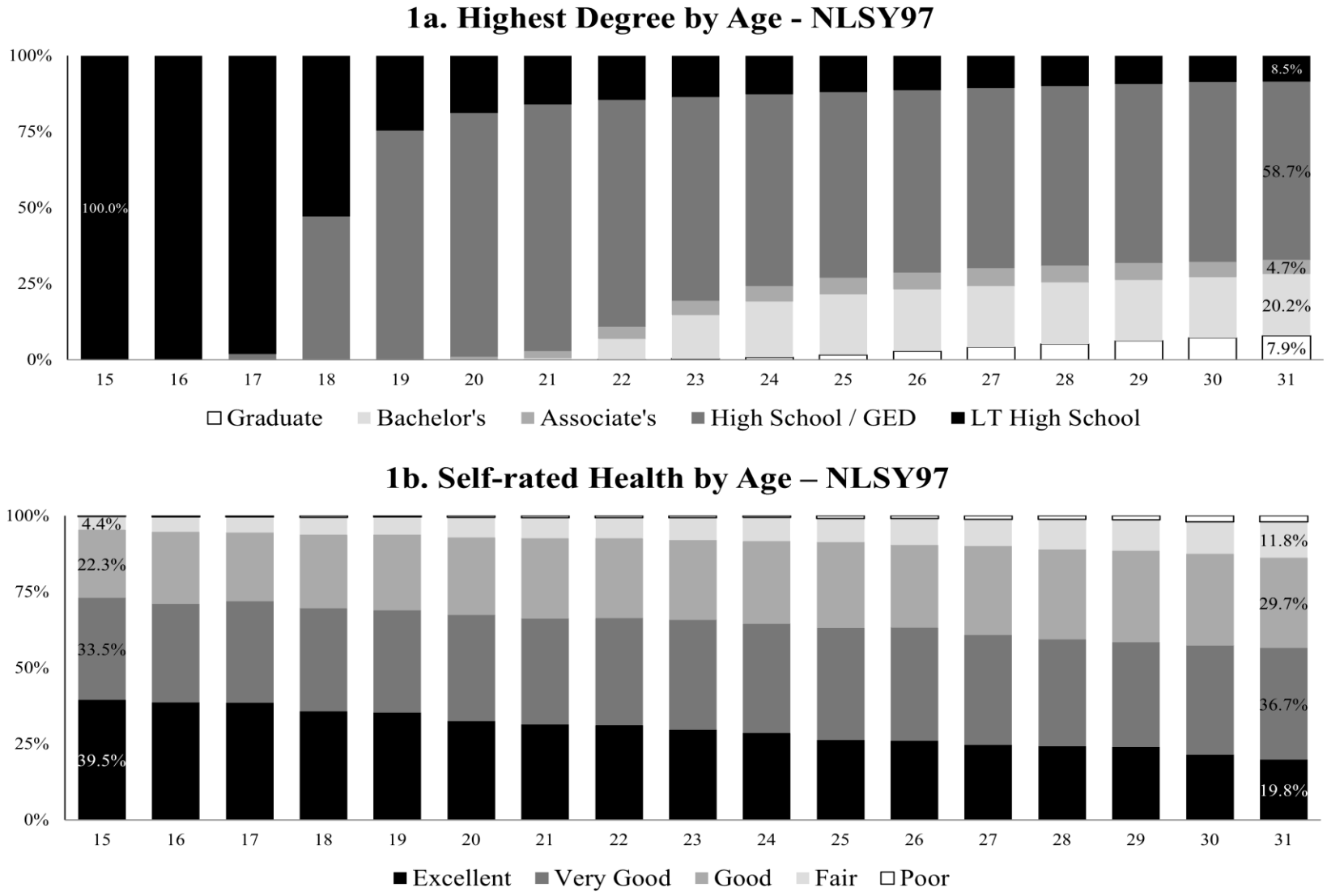

Figure 1. Highest grade completed and Self-rated Health by age, NSLY97.

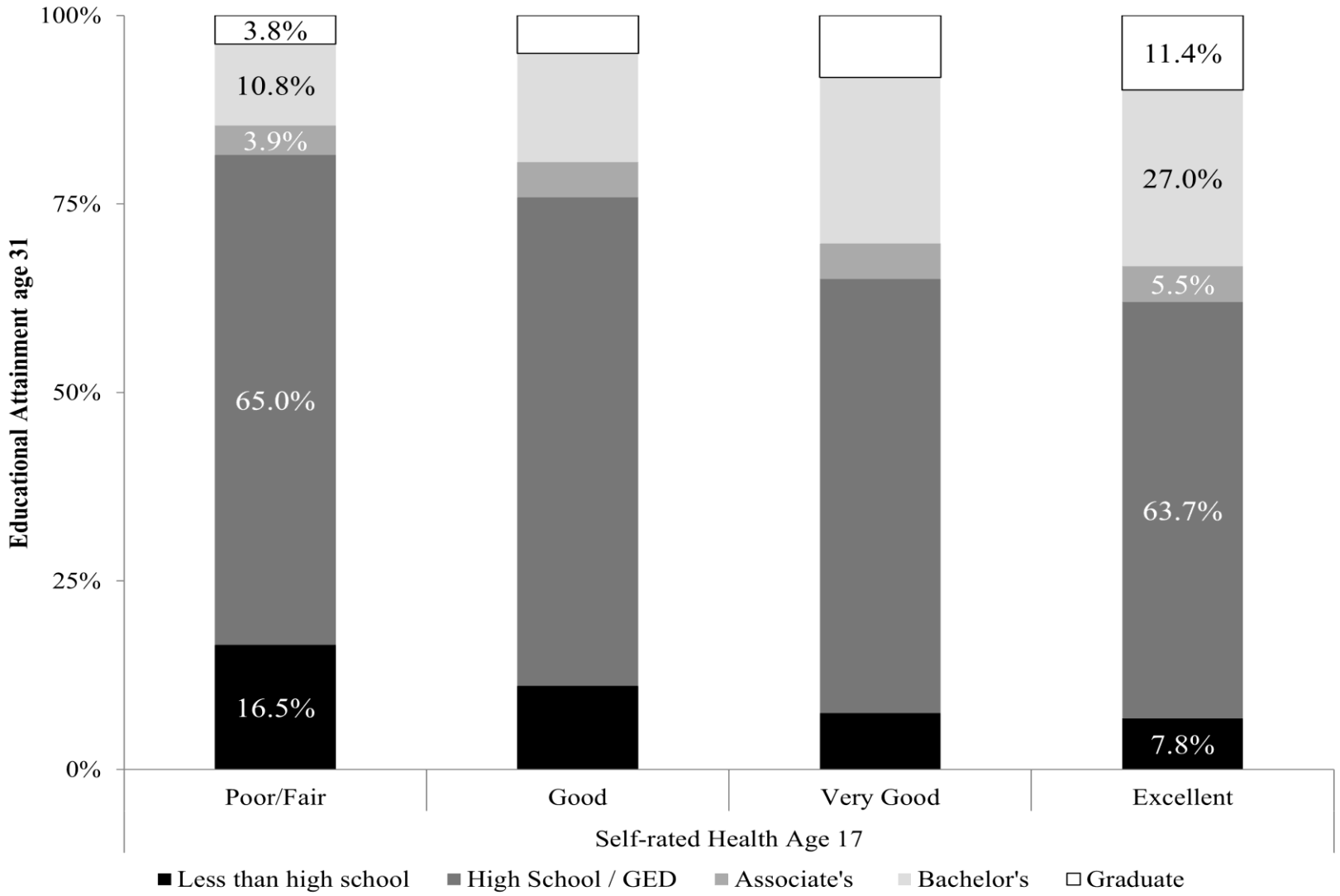

Figure 2. The health gradient in education. This stacked bar chart gives the distribution of educational attainment at age 31, separately for each level of SRH at age 17, NSLY97. The fair and poor categories of SRH have been combined since the number of respondents in each is very small (see Figure 1).

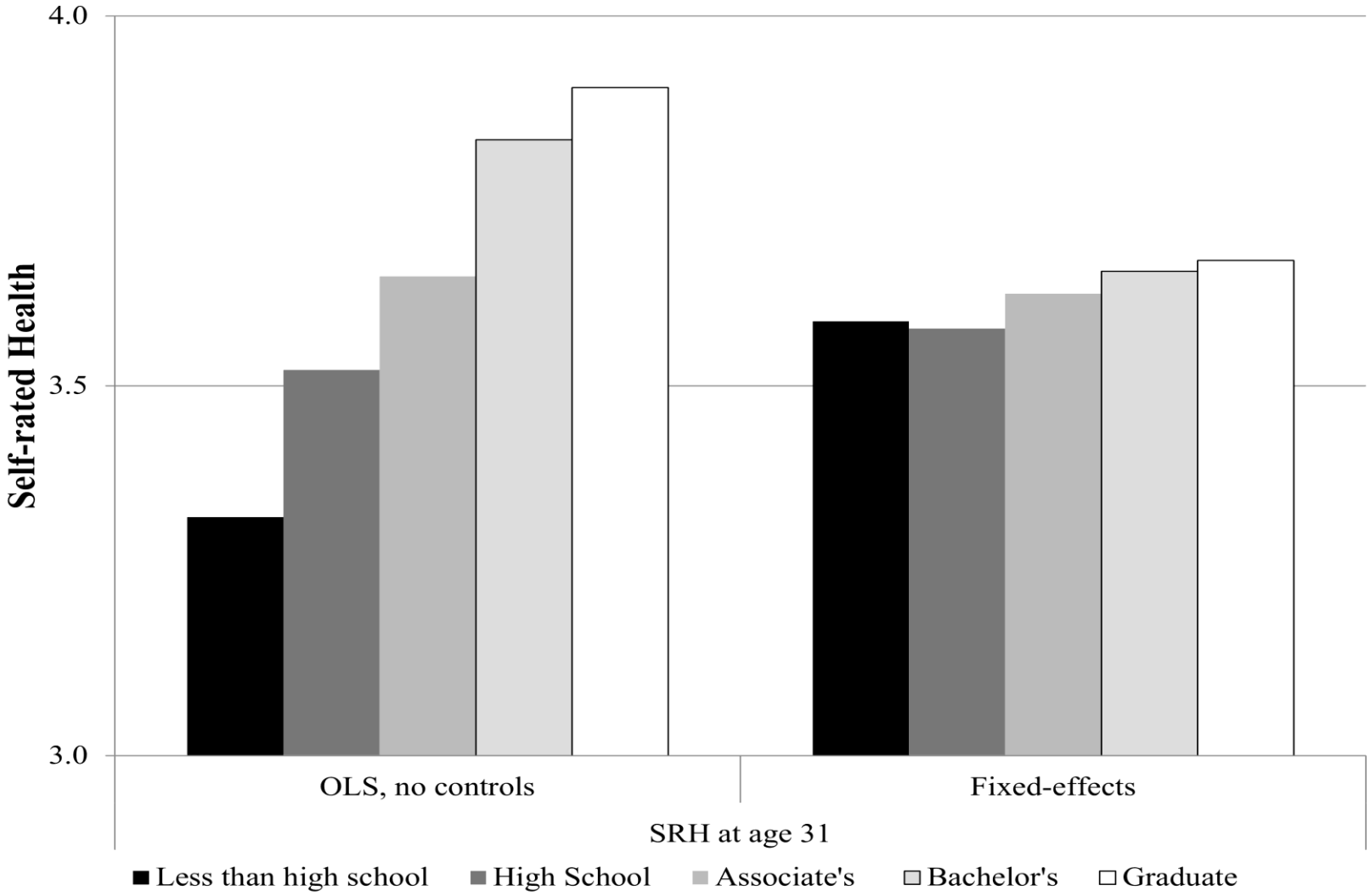

Figure 3. The educational attainment gradient in self-rated health for young adults at age 31 without controls and controlling for all time-invariant factors, NSLY97.

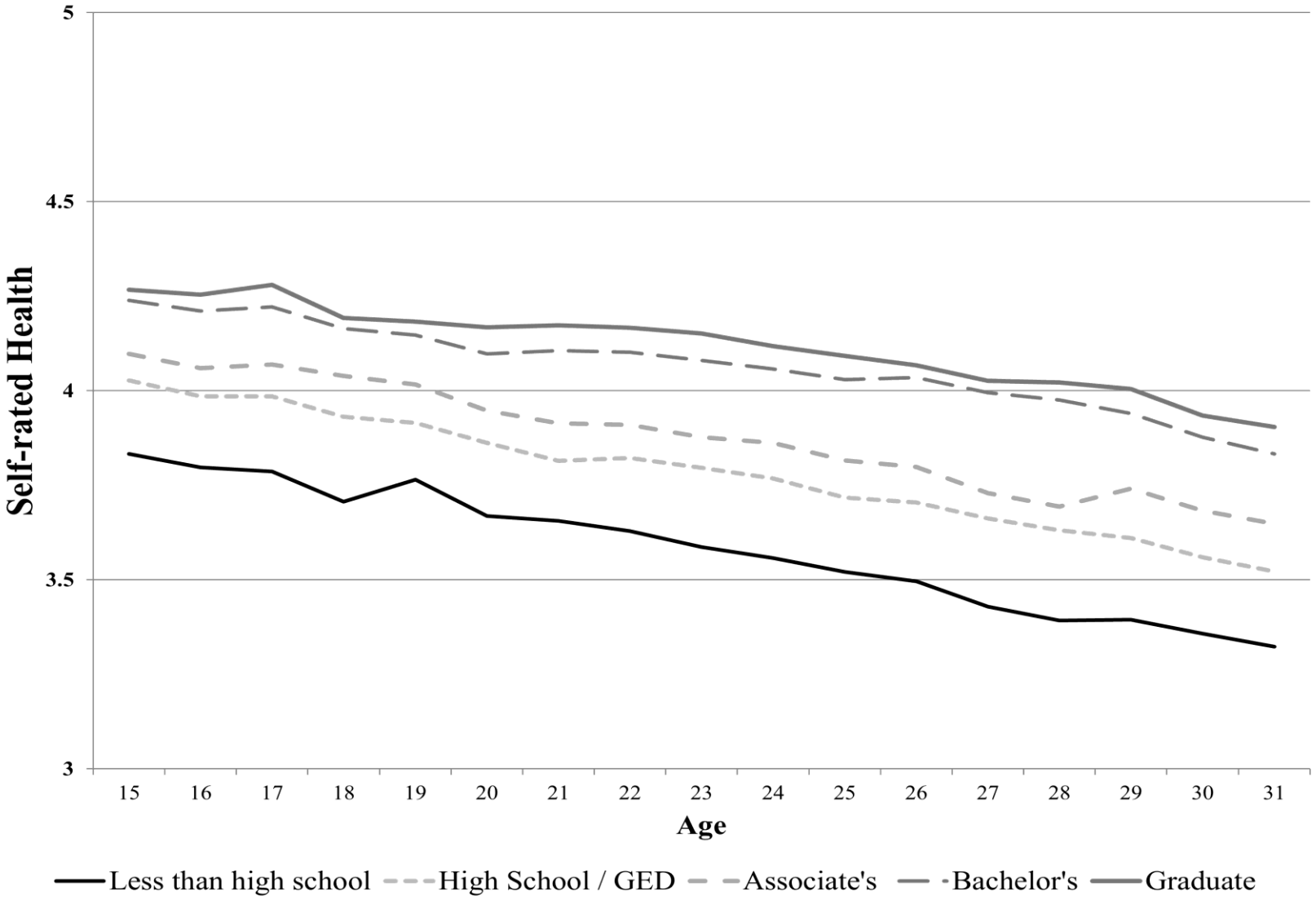

Figure 4. Average self-rated health, from age 15 to 31, for young adults by age 31 highest degree completed, NSLY97.