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Education and Health in Late-life among High School Graduates: Cognitive versus Psychological Aspects of Human Capital

Pamela Herd[1]

Abstract

Just as postsecondary schooling serves as a dividing line between the advantaged and disadvantaged on outcomes like income and marital status, it also serves as a dividing line between the healthy and unhealthy. Why are the better educated healthier? Human capital theory posits that education makes one healthier via cognitive (skill improvements) and noncognitive psychological resources (traits such as conscientiousness and a sense of mastery). I employ the Wisconsin Longitudinal Study (1957–2005) to test the relative strength of measures of cognitive human capital versus noncognitive psychological human capital in explaining the relationship between education and health outcomes among high school graduates. I find little evidence that noncognitive psychological human capital is a significant mediator, but find a relatively significant role for cognitive human capital, as measured by high school academic performance. It is not just higher educational attainment; academic performance is strongly linked to health in later life.

Keywords

aging, disparities, education, human capital, socioeconomic

The link between education and health across the life course has been demonstrated across numerous research designs and measures of health and mortality (for reviews see Cutler and Lleras-Muney 2008; Mirowsky and Ross 2003). Just as postsecondary schooling serves as a dividing line between the advantaged and disadvantaged on measures ranging from income to marital status, it also serves as a dividing line between the healthy and unhealthy. Evidence from the National Health Interview Study demonstrates that for morbidity and mortality the relationship with education is linear after 12 years of schooling. In some cases, such as general health status, the gradient was largest for those with 12 or more years of schooling (Cutler and Lleras-Muney 2008).

Why are the better educated healthier? Human capital theory posits that noncognitive psychological factors (traits such as conscientiousness and sense of mastery) and cognitive factors (verbal, reading, and writing abilities as well as those in mathematics, science, music, and art) which are fostered—or at least rewarded—via schooling lead to better health outcomes via everything from healthy behaviors and health management to higher occupational attainment and incomes (Cutler and Lleras-Muney 2008; Farkas 2003; Mirowsky and Ross 2003). To date, however, there have been few tests of human capital theory, especially the extent to which psychological versus

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cognitive human capital helps explain the relationship between education and health.

I employ the Wisconsin Longitudinal Study (1957–2003/2005) to test the relative strength of cognitive human capital (academic performance) versus noncognitive psychological human capital (personality and psychological orientations) in explaining the relationship between educational attainment and health outcomes among high school graduates. I examine the association between cognitive and psychological human capital measures and change in health over a 12 year period between 1992/1993 (when the sample was approximately aged 53) and 2003/2005 (when the sample was approximately aged 65). While noncognitive psychological human capital has little impact, I find a relatively significant role for cognitive human capital, as measured by high school academic performance, which both weakens the association between education and health and is correlated with health independent of educational attainment. It is not just obtaining a degree or additional years of schooling; academic performance is strongly linked to health in late-life. Strong academic performance may affect health indirectly by facilitating improved occupational attainment and higher earnings earlier in the life course, which ultimately influences health across the life course. The cognitive skills one gains early in the life course via schooling may also more directly impact health—especially in early to mid late-life, with the onset of poor health—via improved health behaviors and better management of chronic diseases that involve complicated treatment regimes.

EDUCATION, HUMAN CAPITAL, AND HEALTH OUTCOMES

Prior research shows that education affects health via its impact on occupation, income, and wealth, and to some extent on health behaviors and health management (Herd, Goesling, and House 2007; Lantz et al. 1998; Lund and Borg 1999). Although occupation helps determine income, it has differential influences on health. Occupational position determines psychosocial and other chemical and physical exposures at work, as well as job security, which can affect health (Karasek and Theorell 1992). Income and wealth are hypothesized to affect health via their impact on material deprivation—such as malnutrition and unsafe homes and neighborhoods and stress that is a product of deprivation—but also broadly inequality (Herd, Shoeni, and House 2008). Finally, those with higher educational attainment are less likely to smoke, be obese, or live sedentary lives, and they are better able to manage chronic diseases such as diabetes (Goldman and Smith 2002).

Recently some scholars (e.g., Mirowsky and Ross 2003) have argued that a broader mechanism links education to health. Education is linked to cognitive and psychological human capital, both of which impact health indirectly, via pathways such as occupation, and more directly, via healthy behaviors and health management. To date, there are few studies exploring this human capital explanation for the link between education and health, especially the relative strength of cognitive versus psychological factors as mediators. Thus, utilizing a unique array of psychological and cognitive human capital measures, this study explores the relative contribution of cognitive versus psychological human capital in explaining the relationship between education and health. Of course, then, the baseline hypothesis (hypothesis 1) is that education has a statistically significant relationship to health outcomes.

PSYCHOLOGICAL HUMAN CAPITAL

Noncognitive psychological human capital is hypothesized to be a critical part of the link between educational attainment and health (House et al. 1994; Cutler and Lleras-Muney 2008; Schieman 2001; Chandola et al. 2006). Mirowsky and Ross (1998) discussed the effect of education:

> [Education] develops broadly effective habits and attitudes such as dependability, judgment, motivation, effort, trust and confidence. . . . Education instills the habit of meeting problems with attention, thought, action, and perseverance . . . [characteristics some call] "personality traits." [T]he process of learning builds the confidence, motivation, and self-assurance needed to attempt to solve problems. (P. 417)

How does psychological human capital impact health? First, it may facilitate occupational attainment and related improvements in earnings earlier in the life course, which ultimately impacts health across the life course (Jackson 2006). Self-discipline, for example, can help get a job and advance up the occupational ladder. Indeed, psychological attributes help explain the link between educational

and occupational attainment (Farkas 2003). Further, improved earnings associated with occupational attainment increases economic security, which impacts health across the life course (House et al. 1994).

Second, psychological human capital associated with schooling may impact health more directly. These skills instilled early on can affect health across the life course by improving healthy behaviors (smoking, obesity, exercise, and alcohol and substance abuse) and health management. Psychological resources provide the self-discipline, for example, to maintain an exercise regime or be vigilant about managing blood sugar levels to reduce debilitating complications from diabetes.

Most longitudinal research has found that psychological factors, which are normally operationalized through a measure of self-esteem or sense of control, mediate about 10 percent of the relationship between years of schooling and self reported general health and physical health (Ross and Mirowsky 1999; Ross and Wu 1995). However, self-esteem and sense of control are narrow measures (Farkas 2003). The inclusion of more psychological human capital measures may mediate more of the relationship between education and health.

Indeed, broader measures of psychological human capital have been linked to mortality and morbidity, though they have not been employed in studies linking education to health (for review, see Roberts et al. 2007). The "Big Five" personality measure—which includes conscientiousness, extraversion, agreeableness, neuroticism, and openness—is one such measure. Another psychological measure linked to health is the Ryff scale, which includes autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. Conscientiousness and purpose in life both measure self-discipline, effort, and the desire to plan for the future, all of which may impact health via higher occupational attainment or better health management. Neuroticism is linked to stress, which in turn may impact health, especially via healthy behaviors. Extraversion, agreeableness, and positive relations with others all facilitate social relationships, which have a profound relationship to health (House, Landis, and Umberson 1988). Environmental mastery and autonomy are closely aligned with one's sense of control, and self-acceptance is an alternative to self-esteem (House et al. 1994; Ross and Wu 1995). Personal growth is similar to openness in that they both emphasize intellectual curiosity and adaptability which may lead individuals to both seek out and adapt their lives to the latest research on ways to improve health (Ozer and Benet-Martinez 2006).

The sociological literature generally assumes that education develops psychological human capital. Indeed, there is evidence that sense of control is developed through schooling and that both personality and psychological well-being measures change across the life course (Caspi, Roberts, and Shiner 2005; Mirowsky and Ross 2007). However, psychological noncognitive attributes may be a form of genetic endowment that enhances status attainment via educational attainment (Farkas 2003; Blau and Duncan 1967). The direction of the relationship needs to be sorted, but only if personality and psychological characteristics mediate a large fraction of the relationship between educational attainment and health.

In sum, if psychological human capital helps explain the relationship between educational attainment and health, it should mediate a portion of the relationship. Thus, hypothesis 2 is that personality and psychological measures mediate a portion of the relationship between the educational attainment and changes in health in early to mid late-life.

Cognitive Human Capital

A key component of human capital health theory is that what we learn in school can improve health (Cutler and Lleras-Muney 2008; Farkas 2003; Mirowsky and Ross 2003). But what constitutes cognitive human capital, and how does one measure it? Farkas (2003) argues that, "human cognitive skills include verbal, reading and writing abilities as well as those in mathematics, science, music and art" (p. 543). Studies testing human capital theory in the context of life course labor market outcomes use academic performance, as measured by test scores or GPAs, as an indicator of cognitive human capital. To date, however, no study focused on human capital health theory has employed a direct measure of cognitive human capital, such as academic performance.

There is significant evidence that education improves academic performance and cognitive ability across the life course and well into old age. Early in the life course, schooling improves standardized test performance and general intelligence as measured by IQ (Blair et al. 2004; Hansen, Heckman, and Mullen 2004). Further, those with

more schooling score better on cognitive testing as age-related cognitive declines start to emerge (Alley, Suthers, and Crimmins 2007; Plassman et al. 1995). Importantly, the effect of education on cognitive aging appears to be independent of childhood IQ (Richards and Sacker 2003).

But how might cognitive skills or academic performance early in life impact physical health across the life course, especially as age-related biological risk for ill health increases? Cognitive human capital is assumed to influence similar factors as psychological human capital does. First, it facilitates better health behaviors and health management. Indeed, early in the life course, younger adults who perform better on academic performance tests are less likely to become regular smokers, with profound implications for late-life health (Kenkel, Lillard, and Mathios 2006; Mueller, Guillory, and Muller 2010). Later in the life course there is a strong correlation between education, cognitive decline (such as Alzheimer's disease and dementia), and morbidity and mortality (Mortimer and Graves 1993). Part of the story may be that reduced cognition impairs self-management of one's health, such as medication management and compliance (Goldman and Smith 2002; Salas et al. 2001).

Second, academic performance, like psychological human capital, may indirectly impact health via occupational attainment. Indeed, secondary school academic performance, holding educational attainment constant, is linked to occupational attainment and wages throughout the life course (Miller 1998; Zax and Rees 2002). Further, higher occupation attainment and income are linked to improved health outcomes across the life course (Herd et al. 2007).

Thus, hypothesis 3a is that academic performance mediates a portion of the relationship between educational attainment and health and is independently related to health outcomes. This would support the theory that cognitive human capital helps explain the relationship between educational attainment and health. One potential weakness of academic performance as a measure of cognitive human capital is that it may reflect traits such as self-discipline or conscientiousness, as opposed to cognitive ability. Imagine two high school graduates, one with high academic performance and one with low academic performance. Is the difference in academic performance between students with the same level of schooling indicative of actual differences in what the students learned? Or is the difference in performance due to the fact that one student was more conscientious and disciplined than the other? Perhaps the high performing student turned in more assignments on time, did not miss exams, and thus received better grades. In short, one may have high grades in school not because one has learned more, but because one is self-disciplined and conscientious. Thus, hypothesis 3b is that the relationship between academic performance and changes in health in early to mid late-life will not be altered by the inclusion of psychological measures.

DATA AND METHODS

The Wisconsin Longitudinal Study (WLS) provides a unique opportunity to examine the links among educational attainment, high school academic performance, personality and psychological characteristics, and late-life health among high school graduates. It is the only source of prospective data that contain early life characteristics (including childhood IQ, childhood health, and parental socioeconomic status measures), schooling experiences (educational attainment, academic performance, and interest), personality characteristics, and late-life health measures.

One weakness with the WLS, however, is that it is a homogenous sample of white Wisconsin high school graduates from 1957. While this has obvious disadvantages, a relatively homogenous sample can help rule out unobserved variables (correlated with educational experiences in childhood and health) which could bias the estimates. Though many observed variables can be accounted for, such as sex, there are numerous correlates, such as cultural differences, which are harder to account for but which are still potential confounders.

This study makes no claims regarding the relationship between education and health among those who did not graduate high school. Why care about educational disparities among those with at least a high school degree? The difference between having a high school degree and post-secondary schooling is a determinant of health (Cutler and Lleras-Muney 2008; Ross and Wu 1995). To demonstrate that the differences in health between those with college degrees and high school degrees is comparable to the differences between those without high school degrees and those with high school degrees, I draw on a sample of those aged 65 and older in the 2005 National Health Interview Study. After controlling for age, race, and gender, the average number of chronic conditions out of the seven possible (asthma, emphysema, stroke,

heart disease, hypertension, cancer, and diabetes) is 2.85 for those without a high school degree, 2.59 for those with a high school degree, and 2.24 for those with a college degree. Overall, these differences were statistically significant ($p < .001$), and the differences are slightly larger between those with college degrees and high school degrees than between those with high school degrees and those without.[1]

The WLS includes 10,317 Wisconsin high school graduates mainly born in 1939. The sample is representative of white, non-Hispanic high school graduates across the United States. Survey data were collected in 1957, 1964, 1975, 1992/1993, and 2003/2005. Interviews in 1992/1993 and 2003/2005, the only waves in which health data were collected, were conducted over the phone and then followed up with a mail survey. In 1992/1993, the health questions were only included in the follow-up mail survey. While the original WLS sample contains over 10,000 respondents, this study analyzes about half of that original sample (4,928 cases). Cases lost to follow-up include: almost 1,300 respondents who died by 2004; approximately 1,400 cases who refused to answer both the mail and the phone surveys in 1992 and 2004; and approximately 1,500 cases who responded to the phone in 1992/1993 or 2003/2005, but did not respond to the mail survey. The remaining missing cases were lost due to information missing on key covariates (educational attainment or high school rank) or on the health measures. The WLS has been ongoing for over 50 years, making sample retention an obvious challenge. Yet, compared to the Panel Study of Income Dynamics (PSID), which lost 50 percent of its sample to attrition over a period of 21 years between 1968 and 1989 (Fitzgerald, Gottschalk, and Moffitt 1998), the WLS has had strong sample retention.

Nonetheless, attrition can pose problems. As with all major surveys, those who were lost due to nonresponse or mortality are less educated. Among those who died in the WLS, 73 percent had only a high school degree, compared to 65 percent in the final sample used in these analyses. Attrition likely weakens the statistical relationship between education and health (Herd 2006), because survivors with lower educational attainment are likely more robust than comparable cases lost due to mortality.

How does attrition affect this study, which aims to parse out the mediating effects of psychological characteristics and academic performance on the relationship between educational attainment and health? I examined the effect of attrition by comparing those who responded to both the phone interview and the follow-up mail survey to those who only responded to the phone interview. Those who failed to respond to the follow-up mail survey (who only responded to the phone interview) had lower educational attainment, similar to those who were lost due to death or nonresponse to both the phone interview and mail survey. Thus, the mail survey had a slightly more educated sample than did the broader phone sample. Because they asked health questions in the phone interview in 2003/2005, I ran two cross-sectional regression models of general health on basic demographics, childhood socioeconomic status, psychological and personality variables, and the education and academic performance variables using the 2003/2005 data: One model used the more restricted mail sample, the other was based on the larger phone sample. There were not large differences in the findings between the phone sample and the more select mail sample. If anything, the academic performance variables had a stronger relationship to health in the larger phone sample, as opposed to the mail sample. The psychological and personality variables had no mediating effect on the relationship between educational attainment and health outcomes in the larger phone sample compared to the mail sample.

Table 1 displays descriptive statistics for the outcome variables and covariates used in models, measures drawn from the 1957, 1975, 1992/1993, and 2003/2005 surveys, school administrative records, and 1957 through 1960 parental tax records. I describe these variables below.

Outcome Variables

The World Health Organization (WHO) defines health as, "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO 1947). I employ two measures of health to operationalize this definition. The first sums the number of chronic conditions reported, producing a summary measure of "disease." The second is self-reported general health. It is correlated with physical, mental, and functional health measures, providing a global measure of health. As with the WHO definition, self-reported health captures more than the absence of disease. Further, unlike number of chronic conditions, general health may capture severity. Two individuals might both have diabetes, but the disease could have different impacts on one's overall perception of his or her health depending on its severity. This measure is highly predictive of mortality (Idler and Benyamini 1997).

Table 1. Descriptive Statistics, Wisconsin Longitudinal Study

	Year, Source	Range[a]	Mean
Outcome Measures			
General health	2003/2005		
Number of chronic conditions	2003/2005	1–5	4.02
Educational Attainment	1957, 1975, 1992/1993	0–11(0–14)	2.01
High school degree			
Associate's degree		0–1	65.86
Bachelor's degree		0–1	5.85
Master's degree		0–1	16.55
Doctoral/Professional degree		0–1	8.94
Cognitive Human Capital		0–1	2.80
School Academic Performance	1957		
High school rank			
Outstanding student		1–100	55.54
Studies interesting		0–1	.13
Studies not interesting		0–1	.62
Psychological Human Capital		0–1	.10
Personality Measures	1992/1993		
Conscientiousness			
Extraversion		2–36 (1–36)	28.80
Agreeableness		2–36(1–36)	22.72
Neuroticism		2–36(1–36)	28.31
Openness		1–30(1–36)	15.81
Psychological Well-being	1992/1993	1–36	21.58
Autonomy			
Environmental mastery		7–42 (1–42)	31.45
Personal growth		8–42 (1–42)	34.01
Positive relations with others		9–42 (1–42)	33.44
Purpose in life		10–42 (1–42)	34.24
Self-acceptance		8–42 (1–42)	34.20
Confounding Covariates		7–42 (1–42)	33.37
Baseline Health Measures			
General health	1992/1993		
Number of chronic conditions	1992/1993	1–5	4.18
Physical symptom severity	1992/1993	0–10 (0–14)	.94
Childhood Cognitive Ability	1957 administrative records	0–42 (0–48)	7.47
IQ			
Parental Socioeconomic Status	1957		103.11
Mother's education (years)			
Father's education (years)		0–20	10.43
Mother's education missing		0–24	9.67
Father's education missing		0–1	.01
Mother worked		0–1	.02
Father's occupational status		0–1	.37
Married parents		41–960	352.53
Parent's income (2008 dollars)	1957–1960 tax records	0–1	.91
Childhood Health	2003/2005	0–200,745	48,025.00
Child general health			
Number of childhood illnesses		1–5	4.29

(continued)

Table 1. (continued)

	Year, Source	Range[a]	Mean
Missed school		0–1	.10
Confined to bed		0–1	.08
Sports restricted due to illness		0–1	.08
Parents smoked		0–1	.07
Demographics		0–1	.75
Male	1957		
Age	1992/1993	0–1	.45
Observations		52–54	52.5

Note: [a]Potential range in parentheses if it does not correspond with actual range of values.

General health status. To measure self-perceived general health, respondents were asked in 1992/1993 and 2003/2005, "How would you rate your health?" Response options ranged in Likert-type style from "excellent" (coded 1) to "very poor" (5).[2]

Chronic conditions. Chronic conditions is a summary measure comprised of 14 chronic conditions. Respondents were asked, in 1992/1993 and 2003/2005, "Has a medical professional ever said that you had": asthma, arthritis or rheumatism, diabetes, serious back trouble, circulation problems, kidney or bladder problems, ulcer, allergies, multiple sclerosis, cancer or malignant tumors, chronic bronchitis or emphysema, heart trouble, stroke, or high blood pressure/hypertension. The measure had a theoretical range from 0–14, though no respondent had all 14 conditions; the actual range in the data was .0–11.

Key Covariates

Educational attainment. This measure is based on highest educational degree attained. Respondents fall into five categories: high school degree, associate's degree, bachelor's degree, master's degree, and doctoral or professional degree (MD or JD). The reference category is those with a high school degree. Using degrees rather than years of schooling standardizes the variable across respondents: A year of post-secondary schooling may mean just one course, whereas a year of secondary schooling is likely to mean something more standard across respondents. There was, however, little difference in the findings regardless of how educational attainment was measured.

Cognitive measures (academic performance). This analysis includes three "cognitive" human capital measures. The primary measure is the students' high school rank, which is a percentile rank based on high school grades (100 – [(rank in class / [# of students in class]) × 100]). Rank was then divided into four categories separated at the quartiles. The reference category is those in the bottom quartile category or the poorest performing students. The correlation between grades and standardized test scores is as high as $r = 0.9$ (Spearman's), which reduces concerns that grades/rank may reflect teacher bias (Willingham, Pollack, and Lewis 2002). The second measure of academic performance captures whether the respondent's teacher noted the child was an outstanding student. Although this measure may reflect teacher bias, it may control for bias reflected in the high school rank measure. The third measure reflects the students' attitude toward learning based on a question in the 1957 survey that asked, "What is your opinion of your high school studies? Interesting, uninteresting, or no special influence?" The reference category is those who said their students had no special influence. This measure may reflect a love of learning (developed in high school) or an inherent interest in learning (rather than one developed in the process of schooling). As a consequence of the imprecise nature of this measure, I interpret it with caution.

Personality and psychological human capital. The WLS includes five personality measures (elsewhere referred to as the "Big Five Inventory" or BFI—see Table 1) (John and Srivastava 1999). The measures were collected in the 1992/1993 survey and are based on self-ratings from 29 questionnaire

items. Each dimension is assessed based on six items (except for neuroticism, which is based on five) that ask individuals the extent to which certain statements apply to themselves. Responses are based on a six point scale where the respondents either strongly agreed, moderately agreed, slightly agreed, slightly disagreed, moderately disagreed, or strongly disagreed. Thus each dimension, like conscientiousness, has a potential range in values from 1–42. The BFI is included in other large surveys (e.g., Midlife in the United States) and is considered a standard personality measure in psychological studies (John and Srivastava 1999). (For detailed information on these measures, see WLS 2008.)

I also include the Ryff scale of psychological well-being (Ryff 1995) (see Table 1). I employ measures collected in the 1992/1993 survey. Responses to the questions that comprised these measures were based on the same six point scale used by respondents to answer the Big Five personality measures. (For detailed information on these measures, see WLS 2008.)

Confounding Covariates

Baseline health measures. All the models include the 1992/1993 baseline measure for each health outcome. The general health model also includes a control for the 1992/1993 baseline number of chronic conditions. All of the models include a physical symptom severity variable that controls for the severity of their health problems. This variable is a summary measure of the severity of discomfort (range of values: 0 = did not have symptom, 1 = no discomfort, 2 = a little, 3 = some, 4 = a lot) which the respondent reported in 1992/1993 for each of 12 physical symptoms: lack of energy, trouble sleeping, fatigue/exhaustion, headache, dizziness/faintness, numbness, ringing in ears, aching muscles, stiff/swollen joints, back pain/strain, chest pain, and shortness of breath. This measure has a theoretical range from 0 to 48.

Childhood IQ. These scores, available through school district administrative records, are derived from the Henmon-Nelson Test of Mental Ability, which was administered to high school students in Wisconsin. It is important to note that, though high school rank and IQ are correlated ($r = 0.58$), there is still meaningful distinction between the two. As with other measures of IQ, this measure is standardized with a mean of 100 and a standard deviation of 10 for the full WLS sample.

Parental socioeconomic status. These measures include: (1) highest number of years of schooling for respondent's mother and father; (2) if information on mother's and father's education is missing; (3) whether the respondent's mother worked outside the home (1 = yes, 0 = no); (4) Duncan Socioeconomic index occupational score for respondent's father's occupation; (5) whether the respondent ever lived in a single parent household; and (6) four year average of parental income, based on Wisconsin tax records, between 1957 and 1960.

Childhood health. Six retrospective childhood health measures were included in the 2003/2005 survey: (1) child general health (excellent, very good, good, fair, or poor); (2) number of childhood illnesses, including asthma, frequent ear infections, removal of tonsils/adenoids, chronic bronchitis, whooping cough, polio, diphtheria, hepatitis, pneumonia, meningitis, or mononucleosis (due to missing information on a small number of illnesses for some respondents, the measure sums the number of conditions a respondent reports having and divides it by the total number of illness questions to which she or he responded); (3) extended absence from school, through age 16, indicated by a question asking whether the respondent ever missed school for one month or more because of a health condition; (4) extended confinement to bed, through age 16, indicated by a question asking whether the respondent was ever confined to bed or home for one month or more because of a health condition; (5) sports restricted, through age 16, indicated by a question asking whether the respondent's sports or physical activities were ever restricted for three months or more because of a health condition; and (6) parents smoked, up until age 16, indicated by a question asking respondents whether their mother and/or father smoked. Items 3 through 6 are dummy measures indicating an affirmative response. Childhood health is coded on a five point scale (1–5), where higher scores indicate better health.

Basic demographics. Additional measures were included to control for sex, age, and race of respondent, though there is little variation by age and race. Sex and race were both dummy variables. Race was coded as black and white.

Models

I test hypotheses by examining the extent to which cognitive and psychological human capital measures mediate the relationship between educational attainment and change in health over a 12 year

period between 1992/1993 (when the sample was approximately aged 53) and 2003/2005 (when the sample was approximately aged 65). I employ an ordered probit regression for the general health outcome and a negative binomial regression for the summary chronic condition outcome. The ordered categorical nature of the general health outcome variable makes an ordered probit model appropriate. The negative binomial model assumes overdispersion of the dependent variable, without an excessive number of zeros. Indeed, the variance on the chronic condition outcome is greater than its mean. Further, a Vuong statistic confirmed that a zero-inflated model was not appropriate for these data (Vuong 1989), and a Poisson model would not be appropriate because having one chronic condition increased the probability of having another.

I employ six models for each outcome variable. Model 1 includes only baseline controls (1992 baseline health measures, childhood IQ, parental SES, childhood health, and demographics), in addition to educational attainment, in order to establish the basic relationship between education and the health outcome measures (hypothesis 1). By controlling for the health outcome measure, as measured in 1992/1993, I essentially measure change in health between 1992/1993 and 2003/2005. Focusing on change in health between 1992 and 2004, in addition to controlling for childhood health measures, helps eliminate potential health selection effects (Haas and Fosse 2008).

Models 2 and 3 add 1992 measures of psychological human capital—personality and psychological well-being variables, respectively—to the measures included in model 1 to test the extent to which they mediate the relationship between educational attainment and health (hypothesis 2).[3] Model 4 adds high school academic performance measures to model 1 to test the hypothesis (H3a) that cognitive human capital helps explain the relationship between educational attainment and health. Finally, models 5 and 6 add personality and psychological well-being variables to model 4 to test whether the relationship between academic performance and health is weakened with the inclusion of psychological measures (hypothesis 3b).

RESULTS

I find that high school academic performance has a substantial relationship to changes in health in early to mid late-life. Further, better academic performance in high school is an important explanatory factor for why postsecondary schooling is linked to better health. In short, it is not simply educational attainment that improves health; academic performance plays a critical role. Personality and psychological orientations, however, do little to mediate the relationship between education and self-reported health and chronic conditions.

Table 2 presents findings from an ordered probit regression where coefficients indicate the average marginal effects of the covariate on the outcome measure, self-reported general health. Model 1 demonstrates that educational attainment has a large and statistically significant relationship to general health. Having a bachelor's, master's, or doctoral/professional degree is related to significantly better self-reported health, compared to possession of a high school degree only. Having an associate's degree, however, is not statistically different than having a high school degree in terms of self-reported health. Interestingly, although results were not presented in the table, IQ was not independently associated with health outcomes after controlling for education.

Models 2 and 3 of Table 2 present findings that provide little support for the hypothesis (H2) that psychological human capital, as measured by personality and psychological well-being, mediates a large portion of the relationship between educational attainment and self-reported health. Model 2 includes the standard Big Five personality measures. While conscientiousness and extraversion have a significant, positive relationship with health, and neuroticism has a significant, negative relationship with health, the inclusion of personality measures has almost no influence on the relationship between educational attainment and general health (as indicated by the educational attainment coefficients). The inclusion of psychological well-being measures (in model 3) also has a limited impact on the educational attainment coefficients, although they do reduce these coefficients by 5 to 10 percent. Having a sense of purpose in life, however, does exert a positive and significant impact on health.

Results presented in model 4 do provide support for the hypothesis (H3a) that academic performance helps explain the link between educational attainment and general health. Educational attainment coefficients are substantially, but not totally, mediated by measures of high school rank, teacher noted outstanding student, and interest in high school studies. These academic performance measures reduce the bachelor's degree coefficient by almost 30 percent from the level in model 1. The

Table 2. Ordered Probit Regression: General Health Regressed on Educational Attainment, Academic Performance, Personality, and Psychological Well-being; Wisconsin Longitudinal Study, 1957–2003/2005[a]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Educational Attainment (reference = high school degree)						
Associate's degree	.0135	.0063	.0056	.0043	.0001	−.0013
	(.0330)	(.0330)	(.0330)	(.0331)	(.0331)	(.0331)
Bachelor's degree	.0887***	.0855***	.0841***	.0639**	.0642**	.0631**
	(.0224)	(.0225)	(.0224)	(.0231)	(.0232)	(.0231)
Master's degree	.0753**	.0718*	.0672*	.0390	.0400	.0357
	(.0283)	(.0285)	(.0283)	(.0293)	(.0295)	(.0293)
Doctoral/Professional degree	.1734***	.1758***	.1600***	.1370**	.1431**	.1290**
	(.0484)	(.0485)	(.0483)	(.0487)	(.0488)	(.0487)
High School Academic Performance						
High School Rank (reference = quartile 1 category)						
Quartile 2 Category				.0503*	.0510*	.0494*
				(.0240)	(.0239)	(.0239)
Quartile 3 Category				.0461†	.0444†	.0404†
				(.0251)	(.0250)	(.0250)
Quartile 4 Category				.0718*	.0719*	.0656*
				(.0289)	(.0289)	(.0288)
Outstanding student				.0759**	.0717**	.0740**
				(.0251)	(.0250)	(.0250)
Studies interesting (reference = No special influence)				.0515**	.0444*	.0452*
				(.0185)	(.0185)	(.0185)
Studies not interesting				.0607*	.0645*	.0629*
				(.0277)	(.0275)	(.0276)
Personality						
Conscientiousness		.0054**			.0048*	
		(.0019)			(.0019)	
Extraversion		.0038*			.0040**	
		(.0015)			(.0015)	
Agreeableness		−.0006			−.0009	
		(.0018)			(.0018)	

(continued)

Table 2. (continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Neuroticism		−.0049***			−.0049**	
		(.0017)			(.0017)	
Openness		.0010			.0006	
		(.0017)			(.0017)	
Psychological Well-being						
Autonomy			−.0003			−.0001
			(.0017)			(.0017)
Environmental mastery			.0020			.0019
			(.0023)			(.0023)
Personal growth			−.0007			−.0007
			(.0019)			(.0019)
Positive relations with others			−.0019			−.0017
			(.0019)			(.0019)
Purpose in life			.0058**			.0054*
			(.0022)			(.0022)
Self-acceptance			.0032			.0031
			(.0021)			(.0020)
Log-likelihood	−4,009.0314	−3,990.6625	−3,992.4804	−3,993.0224	−3,976.1873	−3,978.2612
LR chi^2(df)	1,578.89(28)	1,615.63(33)	1,611.99(34)	1,610.91(34)	1,644.58(39)	1,640.43(40)
Probability > chi^2	.0000	.0000	.0000	.0000	.0000	.0000
Pseudo R^2	.1645	.1683	.1680	.1679	.1714	.1709

$^{\dagger}p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Note: [a] All models control for baseline health measures from 1992 (chronic conditions, physical symptom severity, and general health), childhood IQ, parental SES, childhood health, and demographics. Standard errors in parentheses. $N = 4{,}928$ for all six models.

master's degree coefficient is reduced by about one half and is no longer statistically significant. Also, the doctoral/professional degree coefficient is reduced by 20 percent. Compared to students below the bottom quartile of their class, those at or above the first and second quartiles rate their health about .05 higher on a scale from 1 to 5. Those at or above the third quartile rate their health .07 higher on a scale from 1 to 5. Those reported as outstanding students by their teachers rate their health about .08 higher. This magnitude (in terms of its relationship to general health) is roughly equivalent to having a bachelor's degree as compared to having a high school degree. The interest in learning coefficients produced somewhat counterintuitive results. On the one hand, those who found their high school studies interesting reported significantly better health than did those who said their studies had no special influence. On the other hand, those who said they did not find their high school studies interesting also reported better general health than did those who said their studies had no special influence. A possible explanation is that, while those who report finding their high school studies uninteresting were not sufficiently challenged by their high school academics, they do value learning. Regardless, as already noted, because of the imprecision of these measures, we must interpret with caution the outstanding student and interest in learning coefficients.

Findings in models 5 and 6 (which add personality and psychological well-being measures, respectively, to the variables in model 4) provide support for the hypothesis (H3b) that the relationship between academic performance and health cannot be explained by psychological measures. In model 5, personality measures do not affect the significance level of the relationship between high school rank and general health, though the coefficients for being noted as an outstanding student and for being interested in studies were each slightly reduced; the coefficient for not being interested in studies was slightly increased. In model 6, having a sense of purpose in life (the only significant psychological well-being measure) explained some of the significance of the interest in studies, with a slightly reduced rank coefficient (by about 10 percent for the third and fourth quartile rank categories compared to the first quartile category), but the measure had little impact on the outstanding student coefficient.

What is the magnitude of these effects? In relative terms, standardized coefficients (not presented here) demonstrate that the only variables with a greater influence on general health than the academic performance variables were controls for health. Because I control for the 1992/1993 health outcome measure, in effect, the coefficients represent differences in general health change between 1992/1993 and 2003/2005. In absolute terms, this difference in change was .07 higher for those in the top quartile category of high school rank compared to the bottom quartile category. In short, the health of those in the top quartile category declined less substantially over the 1992/1993 to 2003/2005 period than did the health of those in the bottom quartile category. Given that the difference in average reported general health was .16 between 1992/1993 and 2003/2005, .07 is arguably a sizeable effect.

Table 3 presents results from a negative binomial regression model with chronic conditions as the outcome. In the basic model (model 1), only a bachelor's degree, compared to a high school degree, was significantly associated with fewer chronic conditions. Similar to the general health outcome, IQ (not presented in the table) was not associated with health outcomes.[4]

The findings presented in models 2 and 3 do not support the hypothesis (H2) that psychological resources significantly mediate the relationship between educational attainment and health. In model 2, personality measures (except for neuroticism) neither independently correlate with chronic conditions nor alter the relationship between educational attainment and chronic conditions. In contrast, some of the psychological measures are significantly associated with chronic conditions, though their inclusion had little impact on educational attainment coefficients. While most of these relationships are only marginally significant ($p < .10$), positive relations with others was more than marginally significant ($p < .05$).

The findings presented in model 4 do support the hypothesis (H3a) that academic performance, not just additional educational attainment, is correlated with health outcomes (helping to explain why educational attainment is associated with health). Indeed, the cognitive benefits of schooling substantially mediate the relationship between educational attainment and chronic conditions, cutting the bachelor's coefficient in half and reducing it to statistical insignificance. The higher one's high school rank, the lower the probability of having worsening health over the 1992/1993 to 2003/2005 period. The relationship between rank

Table 3. Negative Binomial Regression: Chronic Conditions Regressed on Educational Attainment, Academic Performance, Personality, and Psychological Well-being; Wisconsin Longitudinal Study, 1957–2003/2005[a]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Educational Attainment (reference = high school degree)						
Associate's degree	−.0288	−.0260	−.0314	−.0253	−.0229	−.0283
	(.0405)	(.0408)	(.0406)	(.0407)	(.0409)	(.0409)
Bachelor's degree	−.0612*	−.0604*	−.0607*	−.0448	−.0434	−.0444
	(.0286)	(.0290)	(.0287)	(.0297)	(.0299)	(.0297)
Master's degree	−.0310	−.0330	−.0272	−.0099	−.0115	−.0071
	(.0367)	(.0373)	(.0369)	(.0380)	(.0385)	(.0382)
Doctoral/Professional degree	−.0558	−.0567	−.0443	−.0336	−.0336	−.0237
	(.0629)	(.0634)	(.0631)	(.0637)	(.0641)	(.0639)
Academic Performance						
High School Rank (reference = quartile 1 category)						
Quartile 2 Category				−.0144	−.0146	−.0164
				(.0299)	(.0299)	(.0298)
Quartile 3 Category				−.0392	−.0406	−.0387
				(.0315)	(.0315)	(.0315)
Quartile 4 Category				−.0969**	−.0984**	−.0937**
				(.0365)	(.0367)	(.0365)
Outstanding student				.0133	.0118	.0121
				(.0320)	(.0320)	(.0320)
Studies interesting (reference = No special influence)				−.0118	−.0111	−.0114
				(.0230)	(.0230)	(.0231)
Studies not interesting				−.0294	−.0307	−.0237
				(.0342)	(.0342)	(.0343)
Personality						
Conscientiousness		.0046			.0055	
		(.0043)			(.0043)	
Extraversion		.0020			.0016	
		(.0019)			(.0019)	
Agreeableness		−.0001			.0003	
		(.0022)			(.0022)	

(continued)

Table 3. (continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Neuroticism		.0045*			.0046*	
		(.0021)			(.0021)	
Openness		.0005			.0005	
		(.0022)			(.0022)	
Psychological Well-being						
Autonomy			.0019			.0017
			(.0021)			(.0021)
Environmental mastery			.0030			.0032
			(.0028)			(.0028)
Personal growth			.0040†			.0039†
			(.0024)			(.0024)
Positive relations with others			.0052*			.0049*
			(.0024)			(.0024)
Purpose in life			−.0047†			−.0044†
			(.0027)			(.0027)
Self-acceptance			−.0048†			−.0045†
			(.0025)			(.0025)
Log-likelihood	−8,088.7192	−8,085.5726	−8,081.5541	−8,083.6419	−8,080.3904	−8,076.9873
LR chi^2(df)	2,042.31(27)	2,048.61(32)	2,056.64(32)	2,052.47(33)	2,058.97(37)	2,065.78(39)
Probability > chi^2	.0000	.0000	.0000	.0000	.0000	.0000
Pseudo R^2	.1121	.1124	.1129	.1127	.1130	.1134

†$p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Note: [a] All models control for baseline health measures from 1992 (chronic conditions and physical symptom severity), childhood IQ, parental SES, childhood health, and demographics. Standard errors in parentheses. $N = 4,753$ for all six models.

and chronic conditions was approximately linear. Indeed, a linear measure, rather than quartile measure, was significantly associated with the chronic condition outcome (results not shown here).

Finally, models 5 and 6 support the hypothesis (H3b) that the relationship between academic performance and chronic conditions is not affected by the inclusion of personality and psychological measures. Neither the personality measures nor the psychological measures alter the relationship between academic performance and chronic condition outcomes (in either the coefficients or their level of significance).

What is the magnitude of these effects? In relative terms, standardized coefficients (not presented here) demonstrate that the only variables with a greater impact than high school rank were controls for health. Because I control for the 1992/1993 health outcome measure, the coefficients represent, in effect, a difference in the change in general health between 1992/1993 and 2003/2005. Thus, in absolute terms, those in the top quartile of high school rank, compared to the bottom quartile, developed .09 fewer chronic conditions between 1992/1993 and 2003/2005. Given that the median number of chronic conditions increased by about 1.0 over this period, this is about a 9 percent lower rate of increase in the number of chronic conditions for those in the top quartile of their class as compared to those in the bottom quartile.

Sensitivity Analyses

I conducted a range of sensitivity analyses, not presented here. I tested whether additional schooling was more beneficial or less beneficial for high performing students by including multiplicative terms for an interaction between education and high school rank. These interaction terms were not statistically significant.

Second, I tested two alternative health outcome variables, each focused on specific chronic conditions. One variable was focused on respiratory health risk (lung disease), and the other was focused on cardiovascular health risk (heart disease). The results from these analyses closely paralleled the overall summary chronic condition measure. The main difference was that in model 1 (controlling only for the highest educational degree attained) the relationships between educational attainment and the lung and heart disease measures were stronger than was the relationship between educational attainment and the summary chronic condition measure.

CONCLUSION

Among a sample of Wisconsin high school graduates from the class of 1957, psychological human capital does little to mediate the relationship between educational attainment and changes in health in early to mid late-life. Among those with comparable educational attainment and childhood IQs, however, those with better high school academic performance (as measured mostly by high school rank) report better health outcomes. It is not just obtaining a degree or additional years of schooling; academic performance is strongly linked to health in late-life. These findings are consistent with the hypothesis that the cognitive benefits of schooling help explain why more schooling is linked to better health, though they cannot be construed as certain causal evidence.

I found little evidence to support the hypothesis that psychological human capital plays a large role in explaining the relationship between educational attainment and health outcomes among high school graduates. Personality measures, ranging from conscientiousness to extraversion and agreeableness, had little role in mediating the relationship between educational attainment and health outcomes among high school graduates. Education coefficients were reduced by only a maximum of 10 percent with the inclusion of psychological measures, and they always remained statistically significant. In contrast, the inclusion of academic performance measures reduced the size of the education coefficients by 20 to 45 percent, and they reduced half of the statistically significant educational attainment coefficients to statistical insignificance.

These findings are not dramatically different from prior research employing longitudinal data, which show self-esteem and self-mastery explain around 10 percent of the relationship between education and self-reported health (Ross and Mirowsky 1999; Ross and Wu 1995). This is somewhat surprising, however, given that this study includes a more comprehensive measure of psychological human capital than prior work. It may be that these psychological components of human capital are mainly important in distinguishing educational health differences between those with and without high school degrees. Future work should encompass high school dropouts.

Future research should consider social network effects not captured by measures of extraversion, agreeableness, or positive relations with others. In short, human capital is comprised of not just psychological and cognitive human capital, but also

social capital. Though sensitivity analyses (not presented here) revealed that measures of student participation in extracurricular high school clubs had no impact on these findings, future work will test more social noncognitive measures.

The findings support the hypothesis that cognitive human capital—which includes skills such as verbal, reading, writing, math, and science—helps explain the link between educational attainment and health outcomes in early to mid late-life. High school academic performance is related to changes in health in mid- to late-life, both through a direct association and by mediating much of the relationship between postsecondary schooling and health. For high school graduates, it is not simply more years of schooling or a degree; academic performance (controlling for childhood IQ) helps determine whether education is beneficial for health.

How might high school academic performance affect general health and chronic conditions? It may impact health indirectly. Cognitive skills, developed early in the life course, may have long-ranging influence via occupational attainment. There is evidence that high school academic performance, independent of educational attainment, leads to higher occupational attainment and higher wages. Then, in turn, both occupation and income exert independent effects on health. Occupational position, for example, determines psychosocial factors as well as other chemical and physical exposures at work, along with job security, which can affect health across the life course and into retirement (Hayward et al. 1989; Karasek and Theorell 1992). Occupation is linked to chronic conditions such as heart disease, hypertension, arthritis, ulcers, and chronic back pain. General self-reported health reflects mental well-being and general physical disability, both of which are influenced by occupation. In turn, higher income, gained via better jobs, influences health via decreased material deprivation and reductions in chronic stress (Herd et al. 2007).

Cognitive skills achieved in high school might have more direct effects on health across the life course via health behaviors and health management. Improved cognition might lead people to eat healthier, exercise more, and drink less alcohol, which could influence the onset of chronic conditions ranging from diabetes to heart disease. Indeed, younger adults with high academic performance scores are less likely to become regular smokers (Kenkel et al. 2006; Mueller et al. 2010). Also, if the general health measure picks up on severity of ill health, higher cognition may lead people with existing health conditions to manage them more effectively so their general health is relatively good. Prior work has found that for both diabetics and people with HIV, the relationship between education and compliance with complex drug treatment regimens is mediated by cognition (Goldman and Smith 2002).

But does strong academic performance simply reflect underlying traits such as conscientiousness and orientation toward the future, traits which might lead them to do well across multiple important life domains, or does the effect of academic performance result from actual cognitive gains associated with schooling? I found little evidence that the effects of academic performance could be explained by these kinds of psychological resources. However, there may be other unobserved correlates. Future work should explore more specific measures of academic performance, such as actual course work and standardized tests.

Future research should examine academic performance over the entire schooling experience. I measured high school academic performance, not college or graduate school academic performance. College or graduate school academic performance might mediate more of the relationship between education and health. But high school grades do predict college academic performance; the correlation is around .70 in most studies (Camara and Echternacht 2000; Rothstein 2004). Further, this study is among the first to separate out the relationships between academic performance (as a measure of the cognitive benefits of schooling) and educational attainment on health outcomes.

If the cognitive benefits of schooling affect health, future work should consider the relative role of these hypothesized pathways. To what extent can the link between academic performance (cognitive skills) and health outcomes be explained by its impact on mediating factors ranging from work to health behaviors and health management?

Finally, there are a few caveats to these conclusions. First, this sample is a relatively homogenous group of high school graduates. This is advantageous from the standpoint of (1) addressing potential unobserved bias and (2) the growing importance of disadvantage between those with high school degrees compared to those with post-secondary schooling. But there are obvious limitations. First, it is harder to make generalizable claims. That said, Link and colleagues (2008), who compared the importance of years of schooling, income, and

IQ on health outcomes in both the WLS and the nationally representative Health and Retirement Study (the same cohort as WLS), found few differences in the relationships between SES and health across these two studies. Nonetheless, these results do not apply to those without high school degrees. The health benefits of schooling for high school dropouts may be linked to psychological human capital. Future work should test this.

Second, I cannot rule out cohort effects. The high school graduation rate in Wisconsin was 75 percent in 1957, compared to 85 percent today. Others estimate that the difference is actually only 5 percent (75 vs. 80 percent) because increases in graduation rates reflect more individuals getting GEDs, not graduating from high school (Heckman and LaFontaine 2007). Post-secondary schooling rates, however, are higher in younger cohorts. College graduation rates between the 1950 and 1975 cohorts rose from 40 percent to 60 percent. What are the implications? If educational attainment is a function of innate ability, the WLS sample may be more select than current cohorts; as the pool of high school and college graduates has expanded, the current pool of high school graduates now includes students with less ability than in prior cohorts. It is not clear, however, how this would affect the findings other than to reduce the sample variation.

This study provides cautionary evidence regarding the benefits of self-discipline, self-mastery, and being forward looking in terms of reducing educational disparities in health among those with at least a high school degree. While these psychological characteristics clearly help determine health outcomes, this study provides little evidence that such characteristics can explain a large part of why post-secondary schooling is beneficial for health. In contrast, these analyses provide support for the hypothesis that the strictly academic and cognitive benefits of schooling may be an important explanation for why educational attainment has such positive health benefits. In short, how well we perform in school has implications for our health.

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NOTES

1. Author's calculation.
2. The responses include "very poor" (5) instead of "fair" (3), which is more common. In 2003/2005 the general health question included "fair" and excluded "very poor." Thus, to test whether this mattered, I ran a cross-sectional analysis using this outcome. I compared this to cross-sectional analyses with the 2003/2005 general health status outcome measure that excluded "fair" as a category. The findings were not meaningfully different.
3. I do not include the entire set of personality and psychological variables in a single model because multicollinearity becomes an issue if all of these measures are included simultaneously.
4. In models that did not include the 1992 health measures, the relationship between attainment and chronic conditions was significant across all categories (except an associate's degree). Including 1992 health measures yields conservative estimates. The finding that high school academic performance mediated the relationship between educational attainment and chronic conditions and general health to a greater extent than did psychological resources was not affected either way.

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Bio

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