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Accumulating Disadvantage Over the Life Course: Evidence From a Longitudinal Study Investigating the Relationship Between Educational Advantage in Youth and Health in Middle Age

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Abstract

Recent studies suggest the importance of examining cumulative risk or advantage as potential predictors of health over the life course. Researchers investigating the cumulative health effects of education, however, have mainly conceptualized education in years or degrees, often disregarding educational quality and access to educational opportunities that may place individuals on divergent academic trajectories. We investigate whether educational advantages in youth are associated with an individual's health trajectory. We develop a novel index of educational advantage and employ random-intercept modeling using data from the National Longitudinal Survey of Youth. We find a widening health disparity in adulthood between respondents with greater and those with fewer educational advantages in youth. Further, among respondents with few educational advantages, blacks experience a greater health burden as they age compared to whites and Hispanics. These results suggest that differential access to educational advantages during youth may contribute to persisting health disparities in adulthood.

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Accumulating Disadvantage over the Life Course: Evidence from a Longitudinal Study Investigating the Relationship between Educational Advantage in Youth and Health in Middle-Age

Research consistently documents that with increasing educational attainment individuals experience less morbidity (Ross and Wu 1995) and greater longevity (Crimmins and Saito 2001). Traditionally measured by degrees or years of schooling, educational attainment is often assumed to be a marker of individual human capital that is fixed after the age of 25 (Krieger and Fee 1994). Although this literature often acknowledges that educational attainment reflects the multiple social contexts and attributes of individuals during their formative years, the tendency to rely on traditional measures of education has resulted in a rather narrow focus on aspects of quantity or credentialism, neither of which adequately account for the underlying mechanisms that place individuals on divergent academic trajectories – such as inequality in both educational content/quality and access to educational opportunities. Moreover, traditional measures of education continue to assume equivalence across racial groups even though research suggests that blacks derive fewer economic and health benefits at a given level of education than whites (Williams and Williams-Morris 2000). Despite the fact that the education literature is replete with studies documenting consistent school inequalities in resources, opportunities, and academic preparation, little research exists examining how these early educational experiences may influence health throughout the life course, independent from and in conjunction with eventual educational attainment.

CONCEPTUAL FRAMEWORK

A Life Course Perspective of Education and Health

This study examines the extent to which educational advantages accumulate over the course of schooling and contribute to widening health disparities as individuals age. This approach is based on the assumption that early advantage/disadvantage can lead to a chain of events that over time increase one's risk of disability and morbidity, that the accumulation of advantage/disadvantage results in a deterioration of health at earlier ages, and that exposures to advantages/disadvantages are socially patterned by race/ethnicity and social position. Indeed, students who enter school at a social or an economic advantage are more likely to acquire a greater number of educational advantages than students who enter school at a social or an economic disadvantage (Darling-Hammond 2004; Lucas 1999). We conceptualize education as a *process* rather than as a fixed attribute of an individual, and argue that the process of education includes not only what occurs within the education system, but also how these experiences are interdependently linked to family, community, and individual attributes. This conceptualization follows the life course perspective that views individual accomplishments (e.g. educational attainment) as part of an evolving interaction between the individual and her social environment (Elder, Johnson and Crosnoe 2003).

Family, school, and neighborhood factors play an important role in the acquisition of educational advantages. Parents' socio-economic status (SES) significantly influences their children's experiences within the education system as well as how much schooling their children eventually complete. For example, even after controlling for a student's academic ability, a student from a high SES background is more likely to be tracked into advanced placement coursework than a student from a low SES background (Lucas 1999). Students enrolled in advanced placement coursework attend college at higher rates than those who do not take this type of coursework (Darling-Hammond and Post 2000). In addition, highly educated parents are

often financially secure and can use their economic resources to advantage their children at school. Such opportunities include enrollment in enrichment programs and after-school tutoring (Lewis 2003), as well as access to important collegiate and employment networks (Orfield and Eaton 1996; Wells and Crain 1994). Moreover, highly educated parents often carry enough political clout with school administrators, teachers, and other parents to ensure that their children acquire the type of academic qualifications that will allow them access to the most selective and elite universities (Wells and Serna 1996).

Beyond family characteristics, school and community factors also impact a child's educational attainment. Because local government provides the majority of funding for public schools, schools reflect the economic situation of the neighborhoods in which they reside (Darling-Hammond and Post 2000). As a result, schools in disadvantaged neighborhoods are more likely to suffer from overcrowded classrooms, outdated books and supplies, fewer advanced placement courses, and fewer computer and science laboratories compared to schools in wealthy neighborhoods (Kane 1999; Lucas 1999). These schools also tend to employ teachers with less training and experience, contributing to smaller learning gains among their students (Darling-Hammond 2004). Furthermore, because neighborhoods remain racially segregated, racial and ethnic minority students are disproportionately concentrated in economically disadvantaged schools, leaving minority students less likely to experience the same level of educational opportunities as their white counterparts (Orfield and Eaton 1996).

Schools may also foster inequalities by reinforcing individuals' beliefs about their place in the social and economic hierarchy (Cottrol, Diamond and Ware 2003). According to Bourdieu (1973), the prevailing meritocratic ideology inherent in the education system reflects the "habitus", or worldview, of the elite, dominant class. This allows individuals from the dominant

group to efficiently maneuver through the education system because the expectations and requirements of the education system essentially match their own. On the other hand, the lower classes are expected to abide by the same "habitus" as the dominant group even if it does not reflect their real-world experience within the education system.

As a student navigates the education system, she may be confronted with critical "selection events" that may influence her academic trajectory. Her ability to control these selection events appears to vary by her personal, family, and school resources, such as her parents' level of education, the quality of her school, teachers' expectations, types of academic courses offered, and the concentration of poverty at her school (Darling-Hammond 2004; Lewis 2003; Lucas 1999). In this way, the education system may reproduce and reinforce existing structures of privilege and power. That is, students who are disadvantaged may have fewer means to control their academic trajectory compared to advantaged students. The accumulation of these multiple events over time may lead to widening gaps in academic success and well-being (Behrman, Rosenzweig and Taubman 1996; Cabrera and La Nasa 2001; Lucas 1999).

Social inequality in the educational process may result in growing health advantages/disadvantages as individuals age (House et al. 1994; Lynch 2003; Miech and Shanahan 2000; Ross and Wu 1996). Cross-sectional and longitudinal studies using traditional measures of education, such as degrees or years of schooling, suggest that the gap between individuals with a college education and those with less than a high school diploma widens over time (House et al. 1994; Lynch 2003; Ross and Wu 1996). As the college-educated age, they are more likely to accumulate a reserve of economic and social resources that can assist them in avoiding and/or delaying the onset of health impairments (Ross and Wu 1996). In addition, the cumulative health advantage of higher education may be becoming stronger in each successive

cohort (Lynch 2003). Given the significant changes in the content, quality, and economic returns of education over the past century, reliance on traditional measures of education likely mask important cohort differences, especially when using cross-sectional or single-cohort panel studies.

While family, neighborhood, and school context influence individuals' educational attainment, these same factors might also induce changes in both short-term and long-term health. For example, childhood SES has been linked to a number of adult health conditions, including all-cause mortality (Hayward and Gorman 2004; Kuh et al. 2002), cause-specific mortality (Davey Smith et al. 1997; Davey Smith et al. 1998; Hart et al. 2000), and functional limitations (Guralnik et al. 2006; Luo and Waite 2005). Because adult SES sometimes fully explains the relationship between childhood SES and adult health (Lynch et al. 1994), adult SES is often seen as a viable measure of long-term SES. Yet, on most occasions adult SES merely attenuates the effect of childhood SES, suggesting that childhood SES independently influences adult health (see for example Guralnik et al. 2006). Indeed, low SES during childhood can induce physiological changes (e.g., blood pressure, cholesterol, bmi) that increase the likelihood of early health deterioration and mortality (Blane et al. 1996). Improving one's social position in adulthood may not translate into a reduction in morbidity (Hart et al 2005). For example, high adult SES is more consistently linked to increased longevity than to decreased adult morbidity in the U.S. (Geronimus et al. 2001; Hayward and Heron 1999; House, Lantz and Herd 2005). These findings are consistent with the perspective that early educational disadvantage can have adverse health effects in adulthood that are manifest even among those who are ultimately successful in their educational human capital investments and able to enjoy economic advantage as adults.

Attending a disadvantaged school can expose students to environmental and social stressors that are also associated with earlier health deterioration. For example, minority-segregated schools experience higher rates of disorder and violence than white-segregated schools (Massey et al. 2003). Prolonged exposure to violence and disorder have been linked to permanent physiological changes that hamper students' ability to learn by diminishing attention span and lowering thresholds of frustration (LeDoux 1986; Massey et al. 2003). These relatively permanent physiological changes may diminish an individual's ability to incorporate and implement important health-enhancing knowledge across the life course, an important resource that may assist an individual in avoiding disease or diminishing its impact once it occurs (Link and Phelan 1995).

Given these observations, our conceptual framework suggests that educational advantages/disadvantages impact health cumulatively over the life course and through multiple pathways, not only through their association with educational attainment or adult income. It also points to the importance of focusing on young and middle-aged adults and on morbidity rather than mortality. Extant studies have provided a good foundation from which to develop our conceptual framework, but we know of no studies that have empirically examined how the total number of educational advantages acquired in youth – and not merely educational attainment – is associated with health, either cross-sectionally or prospectively.

In this study, we examine the association between educational advantages in youth and health-induced work limitations in early to mid-adulthood. First, we hypothesize that higher levels of educational advantages in youth will be associated with lower probabilities of health-induced work limitations in adulthood and with a later age of onset of these limitations, independent of educational attainment. Second, we hypothesize that the gap between those with

greater versus fewer educational advantages will widen with age. This widening is expected because the effects of educational advantages on health impairments are expected to compound over time.

Third, we hypothesize that the effect of educational disadvantage will be more pronounced among blacks and Hispanics compared to whites. This hypothesis is motivated by observations that racial and ethnic minorities generally experience fewer educational advantages (Orfield and Eaton 1996, Lewis 2003), lower educational attainment (Orfield et al. 2004) and more early life disadvantages than whites (Warner and Hayward 2006). Moreover, Geronimus (1996; 2001) has suggested that blacks may encounter accelerated aging due to the accumulation of disadvantages over the life course. Hence we expect that race/ethnicity will moderate the relationship between educational advantages and health across the life course. Further, although our focus is between racial/ethnic groups, we will examine these patterns by gender because the likelihood of having a health impairment varies by gender both between and within racial/ethnic groups (Geronimus et al. 2001; Ross and Wu 1996).

METHODS

Sample

The National Longitudinal Survey of Youth (NLSY) is a nationally representative survey of men and women 14-22 years old in 1979 and includes an over-sample of racial/ethnic minorities. Interviews were conducted annually through 1994 and bi-annually thereafter. We analyze data collected from 1979 through 2002. The retention rate in 2002 was approximately 78 percent (NLSY User's Guide 2003). We do not use sampling weights in our analyses, but unbiased coefficients are produced in unweighted analysis by including the variables that were used to sample respondents (Winship and Radbill 1994).

Our sample includes civilian respondents self-reporting as white, black, or Hispanic (any race). We include respondents queried on health-induced work limitations after age 26. One percent of respondents were lost to mortality prior to age 26 (N=99). Respondents lost to mortality experienced fewer educational advantages and were more likely to be male than respondents included in the sample. After exclusions and attrition, our sample consists of 4,627 non-Hispanic whites, 2,719 non-Hispanic blacks, and 1,704 Hispanics.

Due to the cohort design, the maximum number of interviews respondents provide varied by birth cohort, from 9 interviews among the youngest to 16 among the oldest. Over 83% of the youngest cohort provided at least 7 interviews, while 62% of the oldest cohort provided at least 14 interviews. Approximately two percent of respondents (N=211) had died by 2002 (details available from authors).

The NLSY provides a number of important features that allow us to test the hypothesis that the accumulation of educational advantages in youth is associated with health as individuals age. First, the NLSY collected detailed information on educational experiences, including the type of courses respondents completed in high school, their educational expectations, and school demographics. Such rich education data is critical to testing our hypotheses. Second, individuals were followed from adolescence to middle-age, a span of approximately 23 years. While using a relatively young sample limits our ability to detect changes in health status because younger persons tend to experience fewer health limitations, it does mean that issues of selective mortality that are often of concern in studies of older adults are not as problematic in our sample (Lynch 2003). Furthermore, because school content and quality have changed dramatically over the past eight decades, the schools that older adults would have attended bear little resemblance to schools today. Using a relatively young sample, therefore, means that our findings may be

more relevant to education policy makers and researchers than if we had used a sample of older adults. Nonetheless, one of the shortcomings of the NLSY is that standardized measures of health, which are commonly used in public health and aging research (e.g. ADLs, self-reported overall health), are unavailable. The only health measure consistently collected from 1979 through 2002 was a self-reported measure of health-induced work limitations.

Measures

Health-induced work limitations. Respondents were categorized as "work limited" if they reported "yes" to any of the following questions: 1) "[Are you/Would you be] limited in the kind of work you [could] do on a job for pay because of your health?"; and 2) "[Are you/Would you be] limited in the amount of work you [could] do because of your health?"; and 3) for those not working for pay, "Would your health keep you from working on a job for pay now?" Respondents reporting "no" to all three questions form the comparison group. Measures of health-induced work limitations are highly correlated with disability, functional limitations, health impairments, activities of daily living (ADLs), instrumental activities of daily living (IADLs) and self-reported health (Bound 1991; Burkhauser et al. 2002; Johnson and Wolinsky 1993), and produce comparable findings as measures of self-reported health when used as a dependent variable in multivariate analyses (Bound 1991).

Educational Advantage. We developed an index of advantage to represent certain aspects of the educational process encountered during childhood and adolescence. This index consists of thirteen indicators available in the NLSY that have previously been found to predict college attainment (Cabrera and La Nasa 2001; Lucas 2001). In exploratory analysis these thirteen indicators explained a full third of the variance in college attainment once race/ethnicity and age were controlled (results not shown). Because these indicators increase the likelihood of college

graduation, they can be considered "advantages". We follow the approach of developmental psychologists (Burchinal et al. 2000; Hooper et al. 1998) and sum the indicators into an index to capture cumulative educational advantages. Since some of the indicators are more strongly associated with college attainment than others, we weight each indicator by its independent effect on college attainment. Hence, the index is a weighted sum of these thirteen indicators.

The indicators comprising the index include: 1) expectations of attending college; 2) enrollment in college preparatory classes; 3) not enrolled in remedial English; 4) not enrolled in remedial math; 5) lived with two-married parents at age 14; 6) mother had a college degree; 7) father had a college degree; 8) family subscribed to a newspaper; 9) percentage of economically disadvantaged students attending respondent's high school; 10) percentage of white students attending respondent's high school; 11) percentage of black students attending respondent's high school; 12) percentage of black faculty employed at respondent's high school; and 13) percentage of white faculty employed at respondent's high school.

Respondents' current or last high school administrator, depending on enrollment status, provided data on school demographics as well as information on whether a respondent had ever taken remedial English or math in high school. All other information was obtained via respondents' self-reports. We do not have direct measures of school economic resources, but rely on school demographic characteristics to proxy for school resources given that economically disadvantaged and minority-segregated schools are substantially more likely to be under-funded (Darling-Hammond 2004; Orfield and Eaton 1996). We do not imply that the students at predominately poor and/or minority schools are intellectually inferior or will inevitably experience inferior academic outcomes. Rather our choice of proxy measures is indicative of education-based stratification, which is often associated with fewer educational opportunities.

We categorized the percentage of economically disadvantaged students, the percentage of black faculty, and the percentage of black students as (1) advantage present, if the respondent attended a school that fell within the 10th percentile of the distribution, and (0) otherwise. We categorized the percentage of white faculty and the percentage of white students as (1) advantage present, if the respondent attended a school that fell within the 90th percentile of the distribution, and (0) otherwise. We categorized the remaining indicators as (1) if advantage was present; (0) if not. After weighting each indicator by its independent effect on college attainment, the indicators were summed, resulting in an index with a minimum value of 0 and a maximum value of 16. Higher values indicate greater educational advantage. Because exploratory analysis revealed a threshold effect at approximately the 75th percentile, whereby differences in health-induced work limitations were found between respondents with a score on the index of advantage at or above the 75th percentile and those below the 75th percentile, we chose to dichotomize the index at this cut-point.

Educational Attainment. To investigate whether educational advantages are distinct from educational attainment, we include respondents' educational attainment prior to age 26. Preliminary analyses found a threshold effect at 13 years of schooling. Accordingly, educational attainment is measured using a single indicator that is categorized as 0-12 years of schooling and 13-20 years of schooling.

Socio-demographic Characteristics. To control for potential confounders of the relationship between educational advantage in youth and health in adulthood, we include important covariates that occur *prior* to the completion of educational advantages, educational attainment, and the measurements of health status. These covariates include race/ethnicity, gender, father's, mother's and respondent's nativity status, respondent's residence and

community at age 14, and the occupational status of the female and male residing in the household when the respondent was 14. Race/ethnicity is associated with health status and health-induced work limitations (Geronimus et al. 2001; Hayward and Heron 1999; Williams 1997). Furthermore, race/ethnicity is related to a number of the indicators included in the index of advantage, including school resources, school racial/ethnic composition, family structure, academic rigorousness of classes taken, and parents' level of education (Darling-Hammond 2004; Lucas 1999; Orfield and Eaton 1996). Gender is also consistently linked to health status; females are more likely to report lower rates of physical functioning and poorer overall health than males (Ross and Wu 1996). Additionally, nativity status and the household adults' occupational status are related to educational advantages (Darling-Hammond 2004; Lewis 2003) as well as health status (Abraido-Lanza et al. 1999; Blane et al. 1996).

Statistical Technique

Appropriate to data with repeated measures, we employ a random-intercept analysis. We specify the random-intercept model as follows:

$$\text{logit}[P(Y_{it}=1 \mid \mathbf{X}, \mathbf{Z}, u_i)] = \mathbf{X}_i'\beta + \mathbf{Z}_{it}'\gamma + u_i \quad (1)$$

where $\text{logit}[P(Y_{it}=1 \mid \mathbf{X}, \mathbf{Z}, u_i)]$ is the log odds that respondent *i* experiences a health-induced work limitation at time *t* and assumes that conditional on u_i, Y_{i1} to Y_{in} are independent, t=1,….$\mathbf{T}_i$ is the number of occasions on which respondent *i* was observed, $\mathbf{X}_i'\beta$ is a vector of time-invariant covariates (e.g., those aspects of an individual that do not change over time), $\mathbf{Z}_{it}'\gamma$ is a vector of time-varying covariates (e.g., age, age x sex, etc.), and u_i is a random effect that represents unobserved heterogeneity for respondent *i,* and is assumed to be random and normally distributed with mean zero (Agresti 2002).

Sensitivity Analyses

In additional analyses we compared the estimates derived from the random-intercept model to that of a fixed-effect model. A fixed-effect model carries with it two benefits – it makes no assumptions about the distribution of u_i and it controls for both observed and *unobserved* characteristics that are time-invariant (Agresti 2002). Because fixed effects models control for all time-invariant characteristics, they only provide estimates for factors that vary within person and over time. Thus, analyses are based on cases where the value on the dependent variable changes over time, significantly reducing statistical power. Even so, estimates from the fixed effects and random-intercept models were substantively the same. More importantly, the time-varying effects of educational advantage and educational attainment are equivalent in both models (results available from authors). Because fixed effects models do not provide estimates for time-invariant measures, we report estimates from the random- intercept models only. We also tested for higher order age effects; however, exploratory analysis suggested that the relationship between age and health-induced work limitations is linear, and as such, we do not include any higher order age effects in our model. In addition, we explored the possibility that selective mortality biased our conclusions by running our models on the subset of respondents who had not died during the survey interval. These analyses did not reveal any substantive differences from the results we present.

Missing Data

Rates of item non-response varied by indicator; health-induced work limitations had very low rates of item non-response (<1% in each survey year), indicators of early family life had somewhat higher levels of item non-response, while information provided by school administrators (e.g., school demographics) had non-trivial levels of item non-response (~30%). We utilized a sequential regression imputation method to impute data for all *independent*

variables with item non-response in order to maintain sample size and power (Raghunathan et al. 2002). We did not impute data for the dependent variable. We produced five multiply-imputed datasets; even with a rate of 50% missing information, estimates based on 5 imputed datasets have standard deviations that are negligibly larger than estimates based on infinite datasets (Schafer 1999). Analyses were replicated across all datasets and combined to produce final estimates using methods detailed elsewhere (Schafer 1999).

RESULTS

Descriptive Statistics

Table 1 presents descriptive statistics for each of the indicators included in the index of advantage. In 1979, 37% of respondents reported that they expected to earn a college degree sometime in their life. Only 30% took college preparatory classes during high school while the vast majority of respondents did not take remedial English or remedial math. At age 14, 75% of the respondents lived in a household with two-married parents. Slightly more fathers possessed a college degree than mothers, with 75% of households subscribing to a newspaper when the respondent was 14. The average respondent attended a high school that had a minority of economically disadvantaged students, black students and black faculty.

[INSERT TABLE 1 AND 2 ABOUT HERE]

Column 1 of Table 2 provides descriptive statistics of the sample. The average respondent had a score of 6.29 on the index of advantage. Approximately 51% of respondents are non-Hispanic white, 30% non-Hispanic black, and 19% Hispanic. Half of the sample is female. About 92% of respondents were born in the United States. The majority (65%) of respondents lived outside the South at age 14 and in cities (80%) rather than in rural communities. One in five respondents did not have an adult male present at age 14, but only one

in fifty did not have an adult female present. Occupational status of adults in the respondent's household varied by gender; approximately 7% of adult men were not working, compared to 48% of women.

Columns 2-3 of Table 2 stratify by "high" (at or above the 75th percentile) or "low" (below the 75th percentile) on the index of advantage. Of respondents completing 13 or more years of schooling, 55% experienced high educational advantage as youth, compared to only 8% of respondents completing 12 or less years of schooling. As expected, a greater percentage of non-Hispanic whites experienced high educational advantage (34%) than non-Hispanic blacks (17%) or Hispanics (15%). Respondents born in the South or another country experienced fewer educational advantages compared to respondents born elsewhere. Respondents whose fathers or mothers were born within the United States were also more likely to report high educational advantage than respondents whose fathers or mothers were born outside of the United States. Approximately 60% of respondents who at age 14 lived in households where either the adult male or adult female worked in professional or managerial occupations experienced high educational advantages.

Random–Intercept Model

Random-intercept models examine whether educational advantages in youth directly influences health in early adulthood and cumulatively through middle-age [Table 3}. Race/ethnicity, sex, educational attainment, and the index of advantage are not centered, but all other variables are centered at their grand mean. Age is centered at 26, the age when health-induced work limitations was first assessed, and modeled as [(age-26)/10]. Thus, a one unit increase in age represents change over a decade.

[INSERT TABLE 3 ABOUT HERE]

Model 1 of Table 3 presents estimates of the overall relationship between the index of advantage and health-induced work limitations. We first consider how educational advantages in youth are associated with health-induced work limitations at the initial age of 26. High educational advantage in youth is associated with lower odds of reporting a health-induced work limitation (OR=0.53; 95% CI: 0.42-0.68) at age 26. Female respondents have 129% higher odds of reporting a health-induced work limitation compared to male respondents. Blacks (OR=1.21; CI: 0.98-1.49) and Hispanics (OR=1.19; CI: 0.92-1.34) tend to have higher odds of reporting a health-induced work limitation, but neither relationship is statistically significant.

Next, we examine change in health status as respondents age. A respondent's odds of reporting a health-induced work limitation increase with age. With each additional decade, the odds of experiencing a health-induced work limitation increase 158%. This effect is dampened for respondents with high educational advantage (OR=0.71) as well as female respondents (OR=0.80), and is accelerated for black respondents (OR=1.21). Thus, over the course of a decade, respondents with high educational advantage experience a 29% decrease in their odds compared to respondents with low educational advantage [calculated as ((exp(B))-1 x 100)], females experience 20% lower odds compared to male respondents, and black respondents increase their odds by 21% compared to white respondents.

Model 2 presents estimates of the overall relationship between educational attainment and health-induced work limitations. In general, the estimates are similar between Models 1 and 2, with the notable exception of race/ethnicity. In Model 1, black respondents are not significantly different from whites in their odds of having a health-induced work limitation at age 26; however, in Model 2 the odds ratio for black respondents *is* statistically significant. According to Model 2, black respondents are 24% more likely than whites to experience a

health-induced work limitation at age 26. Educational attainment is also significantly related to initial status and rate of change. At age 26, the odds of experiencing a health-induced work limitation is lower for respondents with high educational attainment in comparison to respondents with low attainment (OR=0.47). In addition, the effect of age is diminished for respondents with high educational attainment; over the course of a decade, respondents with high educational attainment experience a 26% decrease in their odds compared to respondents with low attainment.

Model 3 includes both the index of advantage and educational attainment. Comparing the estimates in Model 3 to the estimates in Model 1 allows us to evaluate the direct effects of the index of advantage by assessing the magnitude of change in the parameter estimates. More specifically, we assume that any attenuation in the effect of the index of advantage once educational attainment is included in the model represents the proportion of the index's effect that is explained by educational attainment. In Model 3, both the index of advantage (OR=0.76) and educational attainment (OR=0.53) remain statistically significant, but the effects for both are attenuated. Educational attainment explains 49% [1-((0.47-0.24)/(0.47))] of the association between the index of advantage and health-induced work limitations at the baseline age of 26. The index of advantage explains approximately 11% of the relationship between educational attainment and health-induced work limitations.

As respondents age, their odds of experiencing a health-induced work limitation increases (OR=2.67), but high educational advantage (OR=0.81) and educational attainment (OR=0.81) dampens the effect of age. In addition, the rate of change for respondents with high educational advantage or high educational attainment is attenuated. The odds in Model 1 (OR=0.71) attenuates in Model 3 (OR=.81) for the index of advantage. Similar attenuation is seen for

educational attainment. Thus, approximately one-third of the cumulative effects of educational advantage is captured by educational attainment and vice-versa. The most important observation, however, was that the index remained an important predictor of health-induced work limitations even after accounting for educational attainment.

[INSERT FIGURES 1A-1D ABOUT HERE]

Additionally, the gender and race interactions seen in prior models remain significant. Females experience a slower rate of change than males, while blacks experience an accelerated rate of change compared to whites. Figures 1a-1d present the predicted trajectories of experiencing a health-induced work limitation from ages 26-46 by the index of advantage and educational attainment, holding all covariates constant at their grand mean and u_i=0. Figures 1a, 1b, 1c, and 1d represent black males, white males, black females, and white females respectively. To simplify the graphs, for each race-gender strata, we compare (a) those with high advantages and high education with (b) those with low advantages and low education.

For all four race-gender strata, the gap widens over time between the high and low educational groups. But, absolute rates are not equal across the race-gender strata, nor are the rates of growth in disparity. For white males this gap grows from less than .5 percentage points at age 26 to 4 percentage points at age 46. The gap between white females grows from 1 percentage point to 6 percentage points over these same ages.

The widening disparity is greater among black respondents, increasing from less than .5 percentage points to 7 percentage points among black males, and from approximately 1 percentage points to almost 11 percentage points among black females. By the age of 46, black female respondents have the highest predicted probability of health-induced work limitations of any group (14%). Furthermore, racial differences among respondents with low educational

advantage and low attainment increase substantially over time. The average trajectories also suggest that respondents with high educational advantage and high educational attainment are able to delay the onset of health-induced work limitations significantly longer than respondents with low educational advantage and low attainment. White females appear to gain the most health benefit, delaying the onset of health-induced work limitations by over 20 years. White males and black females experience a slightly shorter delay at 18 years, while black males experience the shortest at 15 years. Taken together, our findings suggest that not only does low educational advantage and attainment contribute to morbidity among blacks and whites across the life span, but low educational advantage and attainment may also contribute to accelerated aging among blacks.

DISCUSSION

We examined the relationship between educational advantages and health-induced work limitations in light of previous research that consistently demonstrates the existence of a two-tiered education system within the United States. By actively perpetuating existing social inequalities (Bourdieu 1973; Bourdieu and Passeron 1990), the education system has the ability to exacerbate inequalities over time and impact health status throughout the life course (Dannefer 2003). Consistent with this theory, our data show that: (1) greater educational advantage in youth is associated with lower probabilities of health-induced work limitations in adulthood and later onset of health-induced work limitations; (2) the health gap between those with greater versus fewer educational advantages in youth widens with age; and (3) the magnitude of the racial health disparities over the life course is modified by educational advantages. The results also support our hypothesis that the number of educational advantages has cumulative, not static effects, and are consistent with previous studies that find increasing health disparities at older

ages (Geronimus et al. 2006; House et al. 2005; Lynch 2003; Miech and Shanahan 2000; Ross and Wu 1996). Further, the fact that the index remained significant after the inclusion of educational attainment lends additional strength to our contention that early educational experiences influence health through multiple pathways, not only through their association with educational attainment.

We also find that black respondents experience greater odds of health-induced work limitations than white respondents as they age, with the widest racial gap occurring among respondents who have the lowest educational advantages and attainment. The residual racial disparity among disadvantaged respondents is likely indicative of unmeasured experiences of hardship that place disadvantaged blacks at higher risk of poor health at earlier stages in life. Our results are consistent with previous research that suggests an accelerated aging process among disadvantaged black populations (Geronimus et al. 2001). For example, Geronimus and colleagues (2001) found that the probability of experiencing a functional limitation at age 35 for blacks was equal to the probability experienced by whites nationwide at age 55.

Interestingly, Hispanics in our sample did not differ systematically from whites in their odds of reporting a health-induced work limitation even though Hispanics were significantly more likely to have lower scores on the index of advantage and lower educational attainment. Previous studies have demonstrated significant heterogeneity in health between Hispanic sub-groups and whites. For instance, research finds that Mexicans do as well as or better than whites on some health indicators (Carter-Porkras and Woo 1999; Williams and Collins 1995). It is possible that unmeasured heterogeneity within the Hispanic subgroups is related to the non-significant relationship between Hispanic ethnicity and health. Due to severe sample size constraints, we were unable to disaggregate Mexican Americans from other Hispanics, such as

Puerto Ricans or Cubans, but this remains an important consideration for future studies.

Female respondents had higher odds of experiencing a health-induced work limitation at age 26 and a slower rate of increase in health-induced work limitations than male respondents. By middle-age, the disparity between those with greater versus fewer educational advantages was larger among females than it was among males. Further, black females with low educational advantage and attainment reported the greatest predicted probability of health-induced work limitations by age 46. Our results are consistent with previous studies that find that women experience a greater health burden than men throughout adulthood (Ross and Wu 1996), that black women are more likely to suffer from health impairments than white women (Geronimus 2001), and that compared to black men and white men and women, black women often experience the greatest health burden (Geronimus et al. 2006). Although the gender effects may be confounded by female respondents reporting a pregnancy as a health-induced work limitation, any confounding that is introduced is more likely to occur at early ages rather than in middle-age. However, because the NLSY does not distinguish between pregnancy and non-pregnancy related health-induced work limitations, we were unable to test for this possibility. That said, the general patterns are similar between males and females, suggesting that the overall findings of widening disparities by educational advantage are robust.

A key finding is that at age 26, black-white disparities in health were evident when educational attainment was controlled, whereas these disparities disappeared when the index of advantage was controlled. These findings support observations that the measures of socioeconomic position are not equivalent between blacks and whites (Williams and Collins 1995). Traditional measures of educational attainment may not adequately reflect the stratification faced by black children within the education system. Even so, it is important to

recognize that both educational advantage and educational attainment were related to widening disparities in health over the life course. Hence, the type of educational construct one should use varies by analysis, but our data suggests that the accumulation of educational advantages may be a more robust and important predictor of health disparities than educational attainment alone.

Health differences in our study by race/ethnicity, gender, and educational advantage support the idea that the effect of age on health is modified by social position in youth. We speculate that starting school at an advantage is linked to a sequence of selection events that promote additional advantages. Moreover, education-based stratification in youth may increase the duration and intensity of environmental and social stressors across the life-span. Because timing of morbidity is likely connected to past exposures that either delay or accelerate the onset of disease (Geronimus 2001; Stier and Tienda 2001), age may reflect not only developmental processes but may also represent the embodiment of lived experiences (Riley 1994).

Our results provide preliminary evidence that educational advantages acquired in youth directly influence health trajectories through middle-age. It is therefore possible that these early educational experiences influence the onset and progression of other forms of physical and mental impairments across the life course. For example, higher educational attainment is associated with smaller declines in certain types of cognitive functioning during old age (Alley, Suthers, and Crimmins 2007; Farmer et al. 1995). Academic content, the rigor of academic coursework, and education quality, however, each independently contribute to the development of cognitive skills and ability during schooling; individuals exposed to more challenging curriculum and higher quality education develop cognitive skills at a faster rate than those not exposed to these opportunities, resulting in widening disparities in cognitive skills by late adolescence (Darling-Hammond 2004; Farkas 2003). This widening continues into adulthood as

individuals with higher cognitive skills secure more intellectually and socially stimulating jobs compared to individuals with lower cognitive skills (Farkas et al. 1997; Maume, Cancio, and Evans 1996). It is therefore possible that examining early educational experiences may help explicate the well-documented association between years of schooling and cognitive functioning. Future researchers may therefore wish to extend our study into other areas of physical and mental health.

The strengths of this study include its longitudinal design and the use of an index that considers educational advantages as the composite product of characteristics of families, school environments, and individuals. Together, these design features allow us to perform a first test of the hypothesis that the impact of educational advantage on health is cumulative. Future work should continue to evaluate education as a process that actively perpetuates inequality, rather than merely as a static indicator of individual socioeconomic status.

Our study also addresses a current limitation in the literature – that of ignoring or downplaying the role of education-based stratification in youth in producing health disparities over the life course (Dannefer, 2003). Focusing solely on the quantity of education one completes underemphasizes the role of early educational experiences and opportunities in contributing to health disparities. Investigating other aspects of education, including quality/content and access to opportunities, may not only elucidate the mechanisms that link education to health, but may also assist in the development of effective policy interventions that can target those aspects of the education system which work to reproduce existing social and health inequalities. Future work, in particular, should examine other factors in one's educational experience and the relative contributions of the different aspects of education that may be important for health and health disparities.

In addition to those already mentioned, a few other caveats should be noted. First, the index of advantage is a first attempt to measure education-based stratification in youth. We relied on indicators of school composition to proxy for school resources. Data on school resources remains rather limited in most national surveys. Our findings provide preliminary evidence that school resources may matter for health, and highlight the need to include measures of school contexts, environments, and resources in current and future data collection efforts. Second, the NLSY follows only one cohort over time, which limits our ability to generalize our findings beyond individuals born between 1957 and 1964. Future researchers may want to compare our findings to cohorts coming of age in the 1980s and 1990s, especially since educational inequality in these decades was more severe than that experienced by the NLSY cohort (Cottrol et al. 2003). Lastly, the respondents in our sample appear to be fairly healthy individuals. This may be related to both the relatively young ages of our respondents and also the measure of health itself. Our measure likely understates the burden of illness as it does not capture health issues not related to work. Future research should examine whether the same relationship is found between early educational advantages and health when additional measures of physical and mental health are used.

Early educational experiences play a powerful role in determining one's social position in adulthood. Indeed, our results suggest that these early experiences may also play a role in perpetuating health disparities. Future research should continue to examine the ways in which inequality in both educational content/quality and access to educational opportunities augments the aging process. Such studies may have important implications for identifying those fundamental mechanisms that must be targeted if we hope to eliminate health disparities. Our findings also suggest that policies targeted at equalizing school resources may reap advantages

not only for education but also for public health.

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Table 1

Descriptive Statistics of Indicators Included in the Index of Advantage (N=9,050)

	Mean	*SE*
Individual Characteristics [a]		
Expected to attend college in 1979	0.37	(.005)
Enrolled in college preparatory coursework	0.30	(.005)
Did not take remedial English	0.84	(.005)
Did not take remedial math	0.88	(.004)
Household Characteristics [a]		
Lived with two-married parents at age 14	0.75	(.005)
Mother had a college degree	0.07	(.003)
Father had a college degree	0.13	(.004)
Family subscribed to a newspaper at age 14	0.75	(.005)
School Characteristics [b]		
Students economically disadvantaged at respondent's high school	0.24	(.003)
White faculty at respondent's high school	0.81	(.002)
White students at respondent's high school	0.62	(.004)
Black faculty at respondent's high school	0.14	(.002)
Black students at respondent's high school	0.23	(.004)

Notes:

[a] Variables are dummy coded and may be interpreted as unweighted percents

[b] Although we dichotomize school demographic indicators prior to inclusion in the index, we provide the mean and standard errors of these variables in their original form. The estimated means of school characteristics can be interpreted as unweighted percents.

Table 2

Means and Standard Errors of Sample Characteristics (Column 1) and Index of Advantage by Socio-Demographics (Columns 2 and 3) (N=9,050).

	1. Sample Characteristics [a, b]		2. High Educational Advantage [a, b]		3. Low Educational Advantage [a, b]	
	Mean	*SE*	Mean	*SE*	Mean	*SE*
Index of Advantage	6.29	(.140)				
Educational Attainment						
12 years of schooling or less (referent)	0.62	(.005)	0.08	(.004)***	0.92	(.004)***
13 years of schooling or greater	0.38	(.005)	0.55	(.009)	0.45	(.009)
Race/Ethnicity						
Non-Hispanic White (referent)	0.51	(.005)	0.34	(.008)	0.66	(.008)
Non-Hispanic Black	0.30	(.005)	0.17	(.007)***	0.83	(.007)***
Hispanic	0.19	(.004)	0.15	(.009)***	0.85	(.009)***
Gender						
Female	0.51	(.005)	0.25	(.007)	0.75	(.007)
Male (referent)	0.49	(.005)	0.26	(.007)	0.74	(.007)
Respondent's Birthplace						
United States, non-South (referent)	0.57	(.010)	0.29	(.008)	0.71	(.008)
United States, South	0.35	(.005)	0.22	(.008)***	0.78	(.008)***
Outside United States	0.08	(.010)	0.17	(.017)***	0.83	(.017)***
Father's Birthplace						
United States (referent)	0.88	(.003)	0.27	(.006)	0.73	(.006)
Outside United States	0.10	(.003)	0.19	(.014)***	0.81	(.014)***

Never knew father	0.02	(.001)	0.09	(.026)***	0.91	(.026)***
Mother's Birthplace						
United States (referent)	0.89	(.003)	0.26	(.006)	0.74	(.006)
Outside United States	0.11	(.003)	0.20	(.013)***	0.80	(.013)***
Never knew mother	0.00	(.004)	0.06	(.062)*	0.94	(.062)*
Occupation of adult male in household at age 14						
Professional, managerial, white collar	0.18	(.004)	0.62	(.013)***	0.38	(.013)***
Laborer, blue collar (referent)	0.43	(.006)	0.17	(.007)	0.83	(.007)
Sales, clerical, service industries	0.12	(.004)	0.30	(.014)***	0.70	(.014)***
Was not working	0.07	(.003)	0.15	(.014)	0.85	(.014)
No male present	0.20	(.004)	0.13	(.008)***	0.87	(.008)***
Occupation of adult female in household at age 14						
Professional, managerial, white collar	0.08	(.003)	0.60	(.021)***	0.40	(.021)***
Laborer, blue collar	0.13	(.004)	0.13	(.011)***	0.87	(.011)***
Sales, clerical, service industries	0.29	(.005)	0.25	(.010)	0.75	(.010)
Was not working (referent)	0.48	(.005)	0.24	(.007)	0.76	(.007)
No female present	0.02	(.001)	0.10	(.029)***	0.90	(.029)***
Residence at age 14						
US, non-South (referent)	0.63	(.005)	0.28	(.007)	0.72	(.007)
US, South	0.35	(.005)	0.23	(.008)***	0.77	(.008)***
Outside US	0.02	(.002)	0.16	(.027)***	0.84	(.027)***
Community at age 14						
Rural	0.20	(.004)	0.22	(.010)**	0.78	(.010)**
City (referent)	0.80	(.004)	0.27	(.006)	0.73	(.006)

Notes:

[a] Except for the Index of Advantage in Column 1, all variables are dummy coded and may be interpreted as unweighted percents.

[b] Column 1 refers to descriptive characteristics of the study sample. Column 2 refers to the percent of respondents with a given characteristic who have a high score (75th percentile or greater) on the Index of Advantage. Column 3 refers to the percent of respondents with a given characteristics who have a low score (below 75th percentile) on the Index of Advantage

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Table 3

Random-Intercept Model of Health-Induced Work Limitations (N=9,050)

	Model 1		Model 2		Model 3	
	OR	95% C.I. [e]	OR	95% C.I.	OR	95% C.I.
At Age 26						
Index of Advantage (Below 75th percentile reference) [a]						
High Educational Advantage	0.53	(0.42, 0.68)***			0.76	(0.58, 0.99)*
Education (0-12 Years of Schooling reference)						
High Educational Attainment [b]			0.47	(0.39, 0.58)***	0.53	(0.42, 0.65)***
Race/Ethnicity (Non-Hispanic White reference)						
Non-Hispanic Black	1.21	(0.98, 1.49)	1.24	(1.01, 1.53)*	1.23	(0.99, 1.51)
Hispanic	1.19	(0.92, 1.34)	1.19	(0.92, 1.54)	1.17	(0.90, 1.51)
Female	2.29	(1.93, 2.72)***	2.40	(2.02, 2.84)***	2.38	(2.01, 2.82)***
Rate of Change [c]						
Age	2.58	(2.22, 2.99)***	2.61	(2.27, 2.99)***	2.67	(2.33, 3.07)***
Age x High Educational Advantage	0.71	(0.59, 0.86)***			0.81	(0.66, 0.99)*
Age x High Educational Attainment			0.74	(0.64, 0.86)***	0.81	(0.68, 0.95)*

Age x Black	1.21	(1.05, 1.40)**	1.23	(1.06, 1.43)**	1.21	(1.04, 1.40)*
Age x Hispanic	0.91	(0.76, 1.08)	0.91	(0.76, 1.09)	0.89	(0.75, 1.07)
Age x Female	0.80	(0.70, 0.92)***	0.82	(0.72, 0.93)**	0.81	(0.71, 0.93)**
Control Variables [d]						
Respondent's Birthplace (United States, non-South reference) [a]						
United States, South	1.07	(0.83, 1.38)	1.06	(0.82, 1.37)	1.06	(0.82, 1.37)
Outside the United States	0.97	(0.56, 1.68)	0.93	(0.52, 1.65)	0.93	(0.53, 1.64)
Father's Birthplace (United States reference) [a]						
Outside the United States	0.88	(0.60, 1.29)	0.93	(0.63, 1.36)	0.92	(0.63, 1.35)
Never knew father	1.43	(0.86, 2.37)	1.31	(0.79, 2.17)	1.31	(0.79, 2.17)
Mother's Birthplace (United States reference) [a]						
Outside the United States	0.72	(0.49, 1.07)	0.77	(0.52, 1.14)	0.77	(0.52, 1.14)
Never knew mother	1.22	(0.25, 5.94)	1.39	(0.28, 6.84)	1.32	(0.27, 6.47)
Occupation of Male Present in HH at age 14 (Laborer reference) [a]						
Professional/Managerial	0.65	(0.52, 0.82)***	0.65	(0.52, 0.82)***	0.72	(0.57, 0.91)**
Sales/Service/Clerical	0.65	(0.51, 0.83)***	0.66	(0.51, 0.84)***	0.67	(0.52, 0.86)**
Did not work	1.57	(1.17, 2.09)**	1.55	(1.16, 2.07)**	1.55	(1.16, 2.06)**
No adult male present	1.27	(1.04, 1.53)*	1.31	(1.08, 1.58)**	1.29	(1.06, 1.56)**

Occupation of Female Present in HH at age 14 (Did not work reference) [a]						
Professional/Managerial	0.88	(0.65, 1.19)	0.87	(0.65, 1.17)	0.94	(0.69, 1.27)
Laborer/Blue Collar	0.81	(0.65, 1.02)	0.81	(0.64, 1.01)	0.80	(0.63, 1.00)
Sales/Service/Clerical	0.88	(0.75, 1.04)	0.91	(0.77, 1.08)	0.91	(0.77, 1.08)
No adult female present	2.44	(1.45, 4.12)***	2.39	(1.42, 4.03)***	2.35	(1.40, 3.96)**
Place of Residence at age 14 (United States reference) [a]						
South, United States	0.71	(0.55, 0.90)**	0.72	(0.57, 0.93)**	0.72	(0.56, 0.91)**
Outside United States	1.07	(0.62, 1.82)	0.97	(0.57, 1.67)	0.99	(0.58, 1.69)
Community at age 14 (City reference) [a]						
Rural	0.92	(0.76, 1.10)	0.90	(0.75, 1.07)	0.89	(0.75, 1.07)
Var (u_i)	2.42	(2.35, 2.50)***	2.41	(2.34, 2.49)***	2.41	(2.33, 2.48)***
[(LogLikelihood)]		-19080.5		-19046.6		-19036.3
Person-Period Observations		89642		89642		89642

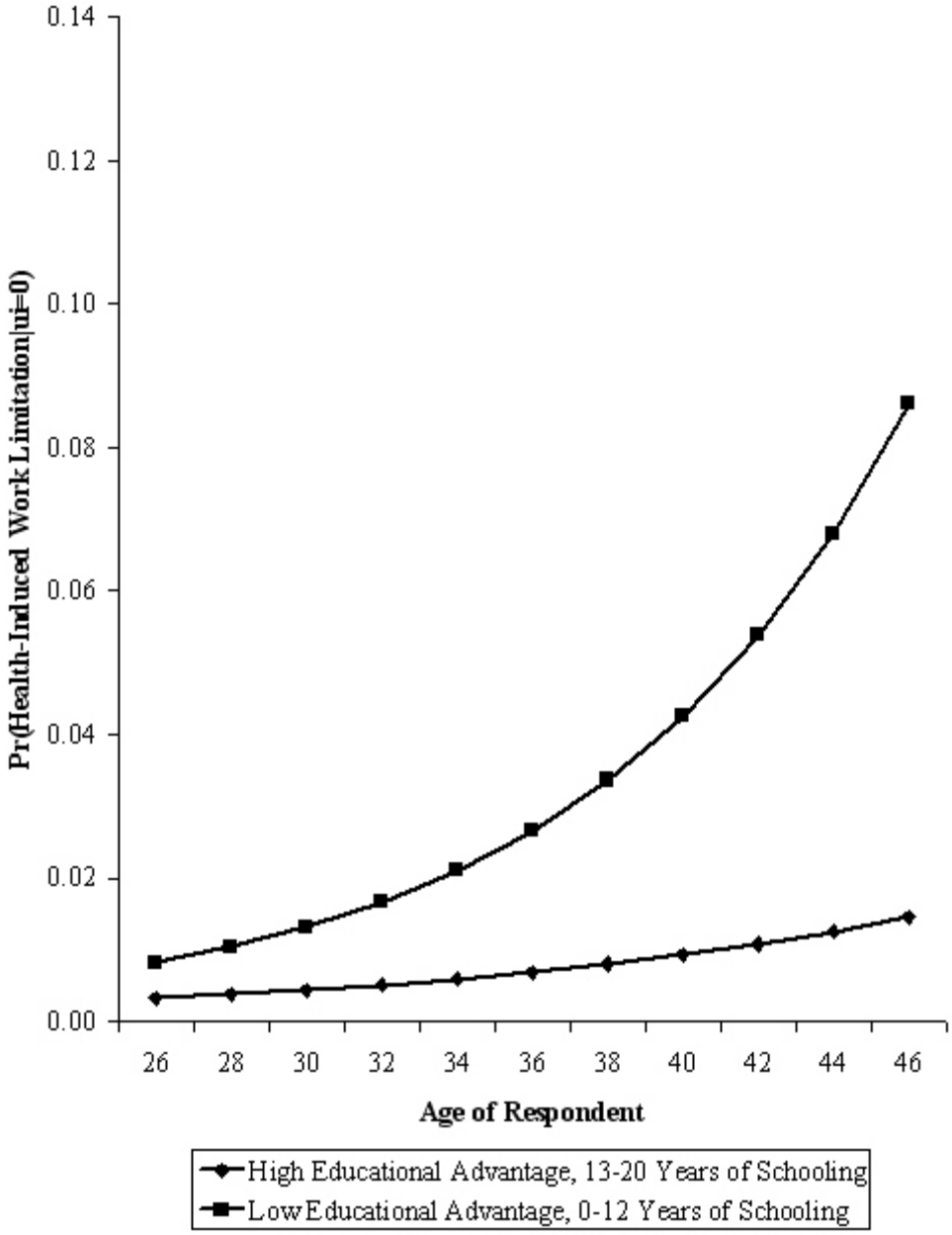
Notes:

[a] High educational advantage refers to respondents at or above the 75th percentile on the index of advantage. [b] High educational attainment refers to respondents with 13-20 years of schooling. [c] Age is modeled as [(Age-26)/10] for main effect and interactions. [d] All control variables are centered at their grand mean. [e] 95% confidence intervals are in parentheses.

* p≤.05; ** p≤.01; *** p≤.001

Figure 1A

Average[a] Trajectories for Black Males by Index of Advantage and Educational Attainment



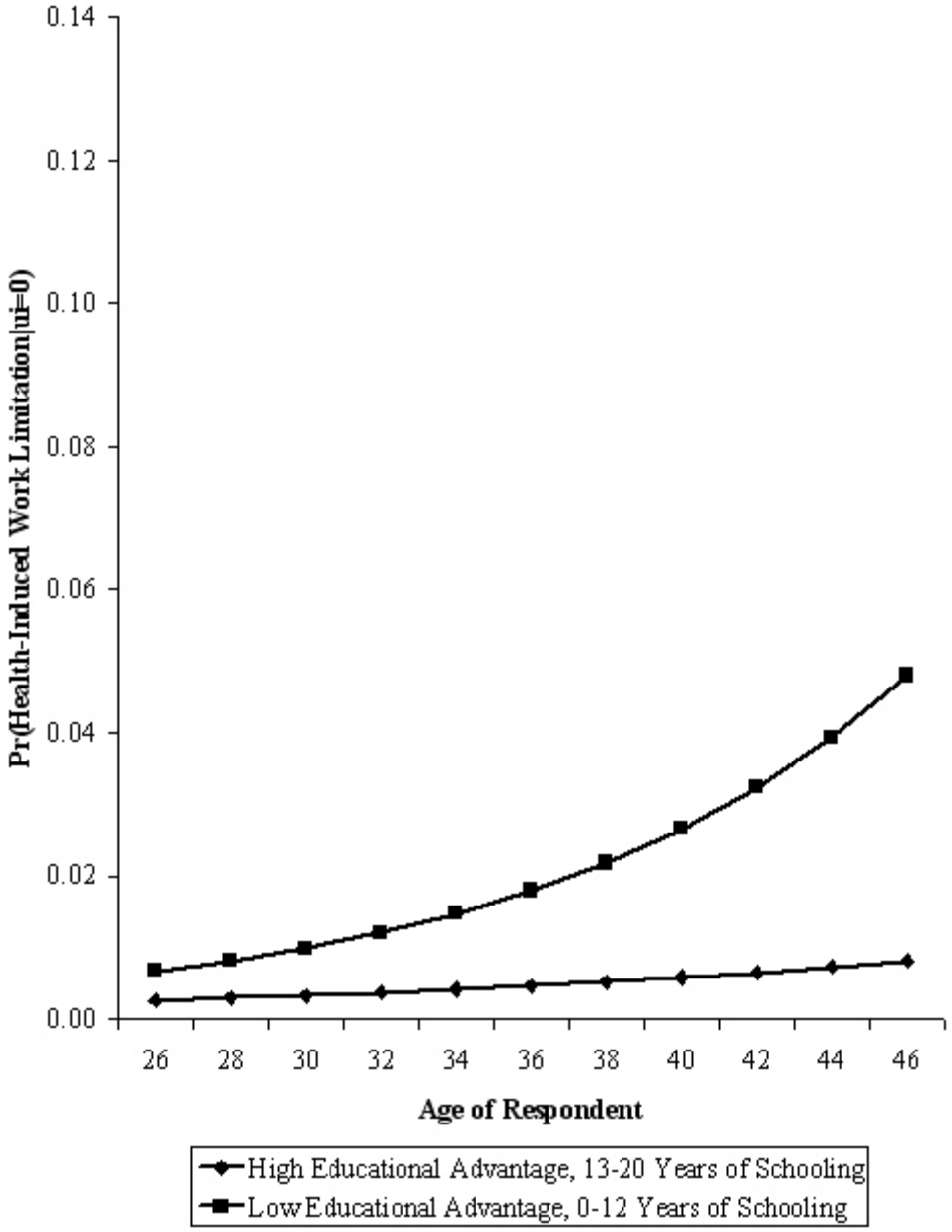
Notes:

[a] Average trajectories of the probability of experiencing a health-induced work limitation between ages 26 and 46 for black male respondents with high educational advantage (75th percentile or greater on index of advantage) and 13

or more years of schooling and black male respondents with low educational advantage (less than 75th percentile on the index of advantage) and 12 years of schooling or less. All remaining covariates are held constant at their grand mean. The random intercept (u_i) is held constant at zero.

Figure 1B

Average[a] Trajectories for White Males by Index of Advantage and Educational Attainment



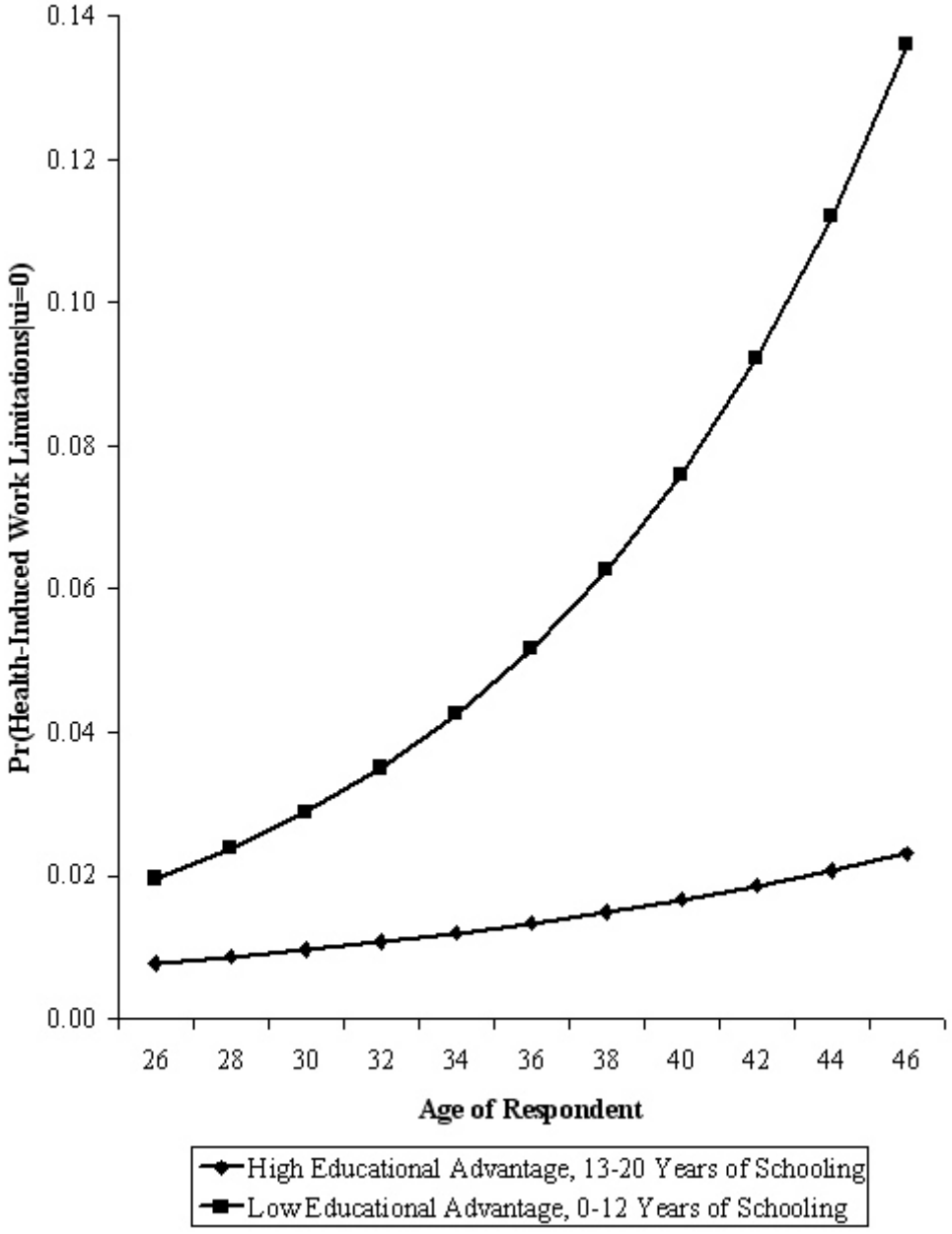
Notes:

[a] Average trajectories of the probability of experiencing a health-induced work limitation between ages 26 and 46 for white male respondents with high educational advantage (75th percentile or greater on index of advantage) and

13 or more years of schooling and white male respondents with low educational advantage (less than 75th percentile on the index of advantage) and 12 years of schooling or less. All remaining covariates are held constant at their grand mean. The random intercept (u_i) is held constant at zero.

Figure 1C

Average[a] Trajectories for Black Females by Index of Advantage and Educational Attainment



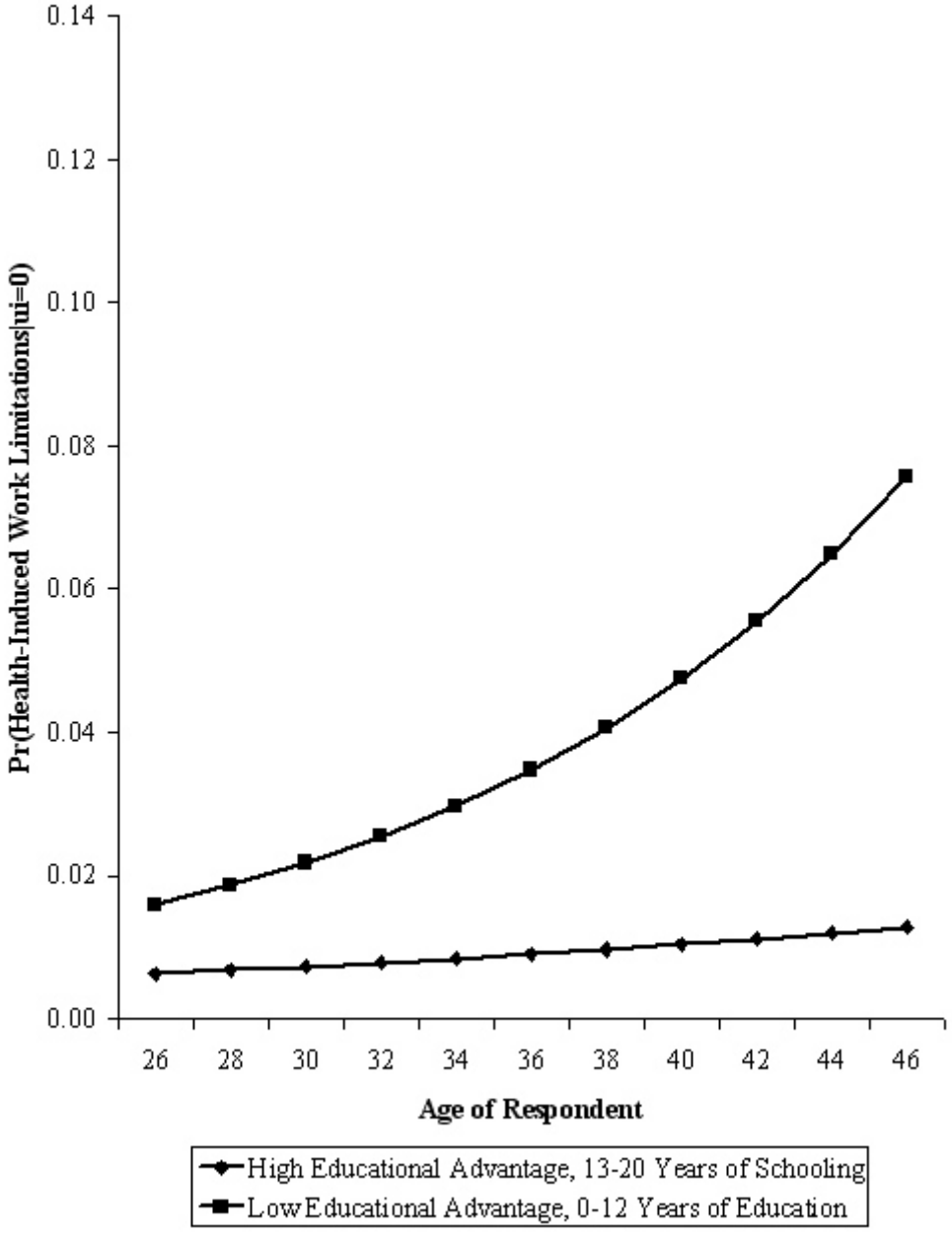
Notes:

[a] Average trajectories of the probability of experiencing a health-induced work limitation between ages 26 and 46

for black female respondents with high educational advantage (75th percentile or greater on index of advantage) and 13 or more years of schooling and black female respondents with low educational advantage (less than 75th percentile on the index of advantage) and 12 years of schooling or less. All remaining covariates are held constant at their grand mean. The random intercept (u_i) is held constant at zero.

Figure 1D

Average[a] Trajectories for White Females by Index of Advantage and Educational Attainment



Notes:

[a] Average trajectories of the probability of experiencing a health-induced work limitation between ages 26 and 46

for white female respondents with high educational advantage (75th percentile or greater on index of advantage) and 13 or more years of schooling and white female respondents with low educational advantage (less than 75th percentile on the index of advantage) and 12 years of schooling or less. All remaining covariates are held constant at their grand mean. The random intercept (u_i) is held constant at zero.