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ABSTRACT

This paper examines the mechanisms linking health to the educational attainment of adolescents. In particular, it investigates the role of cognitive/academic achievement and a variety of psychosocial adjustment factors in explaining this relationship. Using data from the National Longitudinal Survey of Youth 1997 cohort (NLSY97) we estimate models of timely high school completion and post-secondary enrollment using both standard logit estimation and sibling fixed-effects models. We find that net of sociodemographic background and stable unobserved family characteristics, adolescents who experience worse health are substantially less likely to complete high school by their 20th birthday and to subsequently transition to post-secondary education. Cognitive/academic achievement and psychosocial factors appear to explain a large portion of these health-related educational deficits. However, adolescent health continues to be significantly associated with these important educational transitions. The findings highlight a potentially important role of health selection processes in generating socioeconomic inequalities in early adolescence to young adulthood.

INTRODUCTION

The last three decades has witnessed a dramatic increase in research aimed at documenting socioeconomic inequalities in health and in understanding the relationships linking health and socioeconomic outcomes over the life course (Williams 1990; Kitigawa and Hauser 1973). Accordingly, a small but growing body of research suggests a potentially important role of early life health in shaping educational and socioeconomic trajectories (Haas 2006; Case et al. 2005; Conley and Bennett 2000; Wadsworth 1986). In most respects, these findings are consistent with a large and long standing literature documenting the deleterious long-term developmental outcomes of poor infant and child health. However, very little research has attempted to estimate the influence of poor health in adolescence on educational outcomes or to model the mechanisms linking poor health to diminished educational attainment. This study seeks to address these gaps by investigating the academic and psychosocial mechanisms by which poor health may influence the educational outcomes of adolescents.

BACKGROUND

Health and Educational Attainment

Previous research has found that poor health in childhood and adolescence has adverse effects on a variety of educational outcomes. In terms of overall educational attainment, serious illness during childhood and adolescence is associated with significantly lowered odds of acquiring higher order educational credentials in adulthood among participants of the 1946 and 1958 British cohort studies (Wadsworth 1986; Case et al. 2005). Similar investigations in the US based on the Panel Study of Income Dynamics has found that those who experience poor health from birth to age 16 complete on average about half a year less schooling than their peers that experienced excellent childhood health (Haas

2006). Similarly, Conley and Bennett (2000) observed that individuals that are born low birth weight are between 44% and 87% less likely to have completed high school by the end of their 19th year of life.

The influence of poor health on educational attainment is not constrained to its physical manifestations. For example, psychiatric conditions in adolescence are associated with diminished probabilities of successfully making important educational transitions such as high school completion, college entrance conditional on high school graduation, and college completion conditional on college entrance (Kessler et al. 1995; Miech et al. 1999). Externalizing disorders such as conduct disorders appear to more important for earlier educational transitions while internalizing disorders (depression and anxiety) play a stronger role in college entrance and completion (Kessler et al. 1995).

Child and adolescent health has also been found to influence more proximate educational outcomes including academic achievement, course failure, and grade repetition. For example, research has linked chronic disease in childhood and adolescence to lower achievement scores (Fowler et al. 1985). Adolescents who report poor self-rated health or emotional distress are also more likely to experience academic failure (Needham, Crosnoe, and Muller 2004). Similarly, Cadman and colleagues (1987) observed that Canadian children and adolescents with a chronic illness were 40% more likely to repeat a grade or receive remedial instruction. When accompanied by activity limitations, those with chronic illness were five times more likely to repeat a grade. Despite such documentation, very little is known about *why* poor child and adolescent health are associated with diminished educational outcomes. Nevertheless, the literature suggests three possible mechanisms: 1) poor health may proxy for disadvantaged parental

socioeconomic position, 2) poor health may be linked to poor educational outcomes through its effect on academic performance and cognitive development, 3) poor health may operate through poor psychosocial adjustment with peers and school. Each of these is discussed in turn.

Parental Socioeconomic Status and Unobserved Heterogeneity

One explanation for health-related educational impairment may be that it reflects inadequate control for parental socioeconomic status as a common prior cause that structures both child health and academic attainment. The intergenerational transmission of socioeconomic outcomes, including educational attainment, is among the most studied and well established social phenomenon of the last 40 years (Sewell and Hauser 1975; Jencks et al. 1972). Similarly, there is a well established connection between parental socioeconomic characteristics and child health and developmental outcomes (Aber et al. 1997; Duncan and Brooks-Gunn 1997). Therefore, the diminished educational outcomes of children and adolescents in poor health may simply reflect the fact that they come disproportionately from disadvantaged social backgrounds, and that it is their socioeconomic disadvantage that is responsible for both their poor health and their diminished educational attainment.

Previous research has shown that indeed, part of the association between childhood health and educational attainment may be due to such a common causal structure. For example, the addition of controls for demographic and socioeconomic background reduces the negative educational impact of poor childhood health by nearly two-thirds (Haas 2006). However, there typically remains a large and significant negative association between childhood health and completed schooling even after accounting for

parental socioeconomic status (Haas 2006). Therefore, while it is clear that parental socioeconomic status is important, large health-related inequalities in education remain unexplained. Alternatively, it is perhaps more likely that early life health is one of many mechanisms by which parents pass on their socioeconomic position to their children. In other words, the children from socioeconomically advantaged families may excel academically, in part, because they are healthier than their disadvantaged peers. Therefore, childhood and adolescent health may be a causal pathway in the status attainment process. If this is the case then it is important to understand the mechanisms thru which poor health adversely impacts educational outcomes.

In addition to observed family characteristics such as parental socioeconomic status, there may be some unobserved factor or set of factors that lead some children and adolescents to have both poorer health and diminished educational attainment, creating a spurious association between the two. However, previous research by Haas (2006) and Conley and Bennett (2000), have tested for such unobserved heterogeneity through the use of sibling fixed-effects or within-family models. Both studies found that this association held after controlling for all stable (observed and unobserved) family background characteristics. Thus, even within families, individuals that experienced poorer childhood health had significantly worse educational outcomes than their healthier siblings.

Early Life Health, Cognitive Development, and Academic Achievement

Another mechanism that may play an important role linking childhood health and educational attainment is cognitive development and academic achievement. The importance of cognitive factors to the stratification process generally, and educational

attainment in particular is well documented (Jencks et al. 1972; Sewell and Hauser 1975). The influence of early life health on cognitive development likely involves both physiologic as well as social processes. For example, impaired cognitive development may be directly related to a failure of neurological development associated with premature birth or delayed language development due to sensory impairment. Alternatively, premature and chronically ill children have been found more likely to be socially unresponsive to care givers and to have lower levels of social competence (Bugental, Blue, and Lewis 1990; McCormick, Workman-Daniels, and Brooks-Gunn 1996). As a result, caregivers may be less likely to have positive nurturing interactions with these children (Bugental et al.1990). Such interaction has been shown to be critically important to cognitive development and academic achievement (see for example Bradley et al. 1994).

The literature on the relationship between early life health and cognitive development is simultaneously voluminous and narrowly focused. This literature has tended to focus almost exclusively on the neurocognitive consequences of birth outcomes (premature birth and birth weight). Birth weight is positively associated with numerous measures of children's cognitive development and academic achievement (Boardman et al. 2002; Edwards and Grossman 1979). For example, birth weight is positively associated with IQ (Breslau et al 1994; Matte et al. 2001), achievement in reading, spelling, and mathematics (Klein, Hack, and Breslau 1989; Saigal 1991; Johnson and Breslau 2000; Saigal et al. 2000; Breslau, Paneth, and Lucia 2004), and the development of speech/language, visual-motor ability, and memory (Aram et al. 1991; Saigal 1991; Klein, Hack, and Breslau 1989; Halsey, Collin, and Anderson 1993). Increasingly, there

is evidence that low birth weight is also associated with downstream educational outcomes including poor grades, grade repetition, placement in special education, and ultimately high school completion and post-secondary enrollment (Conley and Bennett 2000; Saigal et al. 2000; Del Gaudio Weiss and Fantuzzo 2001). It is important to note that poor educational outcomes are present even among those of "normal intelligence" and without any apparent neurosensory impairment (Saigal et al. 2001).

Despite the large literature documenting the consequences of birth outcomes, much less is known about the influence of childhood and adolescent health more broadly on cognitive development and academic achievement. Studies that have investigated these issues have been somewhat mixed. While some previous research has found children with poor health have worse academic outcomes (Cadman et al 1987 discussed above), others have not found such strong associations. For example, in their analysis of children of the 1979 NLSY cohort, Kaestner and Corman (1995) find only relatively small (yet statistically significant) effects of child health on reading and math PIAT scores. Therefore, while prior evidence reveals a significant relationship between childhood health and impaired cognitive functioning, this is largely based on the analysis of birth outcomes, often drawn from small local clinical samples. Moreover, while there appears to be significant relationships, the associations are inconsistent, and often appear to be rather small, suggesting that cognitive factors may account for only a small portion of the association between health and educational attainment.

Childhood Health and Psychosocial Functioning

In addition to cognitive factors, childhood health may influence academic achievement and educational attainment through a variety of social, psychological, and behavioral

mechanisms. Poor health can be accompanied by physical handicaps that limit athletic and other social activities of the adolescent and thus hinder peer interaction and the development of strong social relationships. The presence of a physical disability may also lead the adolescent to be the subject of stigma and ridicule. Such stigma may take on a gendered dimension as boys with health problems may be perceived as weak and girls as less attractive. This can adversely impact self-esteem, contribute to social isolation, and promote submissiveness. In more severe cases, this can manifest in outright bullying or other forms of violence. The net effect could be to alienate the adolescent from the educational environment and weaken commitment to school. In the case of violence, they may further come to associate school with fear and the lack of personal safety. Previous research has linked peer victimization to loneliness, negative school affect, school avoidance behaviors, and ultimately to low academic achievement among young children (Ladd, Kochenderfer, and Coleman 1997; Kochenderfer and Ladd 1996).

As with cognitive outcomes, the majority of studies investigating the impact of poor childhood health on psychosocial functioning have focused almost exclusively on birth outcomes. Low birth weight children are at greater risk for problem behavior and hyperactivity (McCormick, Workman-Daniels, and Brooks-Gunn 1996; Szatmari et al. 1990; van Os et al. 2001), they are also perceived as less competent in their social activities by their parents (McCormick, Workman-Daniels, and Brooks-Gunn 1996). Zelkowitz and colleagues (1995) observed that very low birth weight (<1500g) 9 year olds were more anxious and withdrawn than normal weight controls.

Chronic illness has also been shown to have adverse impact on psychosocial functioning and behavioral adjustment (Cadman et al. 1987; Mulhern et al. 1989;

Gortmaker et al. 1990; Meijer et al. 2000). In a clinical sample of Dutch children, Meijer and colleagues (2000) find that chronically ill children are more submissive and have more restricted social activities than their healthy peers. Population-based studies have documented substantial social, psychological, and behavioral difficulties among chronically ill children and adolescents. Cadman and colleagues (1987) observed a more than two-fold increased risk of a number of psychiatric disorders including neurosis, conduct disorder and ADHD among Canadian children and adolescents with a chronic illness. When accompanied by disability chronically ill children were also more almost twice as likely to have problems getting along with their peers, to have a low level of participation in social activities, and were more than five times more likely to have either no friends or only one friend that they saw infrequently (Cadman et al. 1987). Similarly, Gortmaker and colleagues (1990) found that chronic illness increased total score on a behavioral problems scale as well as antisocial, anxious/depressed, headstrong, hyperactive, and peer conflict/social withdrawal subscales. Overall children with chronic illness had 44% greater odds of being in the top 10^{th} percentile on the behavioral problem index (BPI) (Gortmaker et al. 1990).

HYPOTHESES

The preceding discussion reveals large gaps in our understanding of the mechanisms linking health in childhood and adolescence to educational attainment. Much of the literature has focused narrowly on birth outcomes, arguably an imperfect proxy for the overall health status of children and adolescents. Moreover, we are not aware of a single study that has explicitly attempted to model the *mechanisms* linking late childhood and adolescent health to educational attainment in young adulthood, particularly in a

nationally-representative, population-based longitudinal sample of youth. Given the above discussion we hypothesize that 1) adolescent educational attainment will be adversely impacted by poorer health. That is, we hypothesize that adolescents in poorer health will be less likely to finish high school in a timely fashion and will be less likely to transition to post-secondary education. 2) We hypothesize that this association will remain after accounting for sociodemographic characteristics of the adolescents, parental socioeconomic position, and stable unobserved family characteristics. 3) Finally, we expect this association to be, at least in part, mediated by the cognitive/academic achievement of the adolescent and by their psychosocial relationships with peers.

METHODS

Data

To test the above hypotheses this study uses data from rounds 1-7 (1997-2003) of the National Longitudinal Survey of Youth 1997 cohort (NLSY97). The NLSY97 is an ongoing nationally representative panel study of 8,984 youths aged 12-16 on December 31 1996. The sample consists of a nationally representative sample of 6,748 youths born between January 1 1980 and December 31 1984 and an over sample of 2,236 Hispanic and non-Hispanic black youth born during the same period. During initial screening 9,806 individuals were sampled yielding a 91.6% response rate at baseline. As of the seventh wave of data collection (2003) 7,756 (86.3%) respondents remained in the sample with 1,228 respondents (13.7%) lost to attrition.[1] For timely high school completion our analytic sample consists of 8,050 adolescents who had reached their 20th birthday by the time of the 2003 interview, or had completed high school if they were younger then 20. To avoid censoring, we drop those who had not yet completed high

school and had not yet reached their 20th birthday by 2003. For post-secondary enrollment we restrict our analysis to the 6,988 adolescents who completed high school (at any age) between 1997 and 2003.

The NLSY97 documents the transition from school to work and into adulthood. Sources of data include the youths themselves via a self-administered questionnaire and parents. Information is also collected from school transcripts. The content of the survey includes extensive information about youths' educational experiences over time. Educational data include youths' schooling history, performance on standardized tests, course of study, the timing and types of degrees, and a detailed account of progression through post-secondary schooling.

While many measures analyzed are derived from the youth questionnaire, information on household income, household net worth, biological parents' education, and youths' emotional and learning problems, were derived from the wave one parent questionnaire. The selection of the responding parent was based on the following pre-ordered list: biological mother, biological father, adoptive father, adoptive mother, stepmother, stepfather, guardian or relative, foster parent, or other non-relative who has lived with the youth for two or more years. If no parent-type figure or parent is was available then no parent was interviewed.

Measures

The analysis utilizes two measures of adolescent educational attainment. *Timely high school completion* is a dichotomous measure indicating whether or not the respondent had graduated from high school or received a GED by their 20th birthday. Previous research has shown that if high school is not completed in a timely fashion then it is more

likely to be a GED and thus to reflect the lower market returns than a high school diploma (Cameron and Heckman 1993). They are also less likely to go on to a four-year college (Horn and Carroll 1996). A second indicator measures whether or not the youth has ever enrolled in *post-secondary education* conditional on high school completion.

Adolescent Health

Our primary independent variable of interest is self-reported health status. In each wave, adolescents were asked "in general how is your health?" Response categories included excellent (1), very good (2), good (3), fair (4), and poor (5). Larger values represent worse self-rated health. Among adults, research has shown self-rated health to be a reliable and valid measure of general physical well-being that is highly correlated with objective measures of physical health, including mortality risk and physician's assessments (Idler et al. 2004; Idler and Kasl 1991). Unfortunately, very little research has examined the quality of self-rated health among children or adolescents. Recently, Boardman (2006) examined the measure of self-rated health in the National Longitudinal Study of Adolescent Health (Add Health) finding that it is moderately stable over repeated observations (interclass correlation of 0.55). It is also clear that among adolescents, self-rated health is capturing both physical and psychological dimensions of well-being (Boardman 2006). Our own assessment of self-rated health in the NLSY97 (not shown) found that it was strongly correlated with the presence of a serious activity limiting chronic health condition, physical deformity, and mental/emotional disturbance. There was also a significant association between self-rated health and both BMI and depressive symptomology. To account for the relative instability in the measure and to minimize the associated measurement error we use an average of the reports of self-rated

health over the first two waves. By averaging two reports of self-rated health we are more likely to capture enduring underlying health problems and the measure should be less sensitive to short-term or otherwise transitory health events that may influence self-reports of health at given observation.[2]

Academic Achievement and Psychosocial Mediators. Measures of academic achievement include the age-adjusted percentile on the computer adaptive version of the Armed Vocational Services Aptitude Battery (ASVAB). Respondents were grouped into age cohorts of three months each, and their performance on the ASBAB verbal and mathematic components were rescaled as a percentile *vis-à-vis* other respondents in each age cohort. Specifically, this score includes the percentile subtest scores of mathematical knowledge, arithmetic reasoning, word knowledge, and paragraph comprehension.

At the first wave those respondents who had completed the 8th grade were asked to report the grades from their 8th grade year. In subsequent years, as younger respondents completed the 8th grade they were also asked about their grades that year. Responses are coded as following: .5="mostly below Ds", 1="mostly Ds", 1.5="half Cs and Ds", 2="mostly Cs", 2.5="half Bs and Cs", 3="mostly Bs", 3.5="half As and Bs", 4="mostly As." In addition, we include a dummy variable indicating whether the respondent has ever repeated a grade. Finally, as illness may interfere with the educational process due to repeated school absences we include a measure of the number of school absences in the past year top-coded at ten. In the first wave, the respondent's parent was asked if their child currently or "ever had a learning or emotional problem that limits or has limited the kind of schoolwork or other daily activities [he/she] can perform,

the amount of time [he/she] can spend on these activities or [his/her] performance in these activities. Affirmative answers are coded 1, negative responses were coded 0.

A series of measures provide insight into the youths' *psychosocial relationships to peers and school*. First, the respondent is asked respond to the following statement "I [feel, felt] safe at this school." Respondents were coded as 1 if they agreed or strongly agreed and zero if they disagreed or strongly disagreed. The other three measures of psychosocial relationships are dummy variables where 1=yes, 0=otherwise. The first variable indicates whether the respondent has ever had "someone threatened to hurt" them at school. The second indicates whether the respondent has "ever attacked someone with the idea of seriously hurting them or have a situation end up in a serious fight or assault of some kind?" The final measure indicates whether the respondent was "ever the victim of repeated bullying" between the ages of 12 and 18.

Social and Demographic Controls. Demographic variables include the respondents' gender (where 1=male), a dummy variable indicating whether the respondent speaks a language other than English at home (1=yes) and a continuous measure of the respondents' age during the first wave of the survey. Race/ethnicity is measured using a series of dummy categories corresponding to non-Hispanic black and Hispanic/Latino (non-Hispanic white is the reference category). Due to their small numbers all others are dropped from the analysis. We also control for the adolescent's socioeconomic background. All of our measures of family socioeconomic status are derived from parental reports taken from the round 1. These measures include biological fathers' and biological mother's highest grade of completed schooling. The responding parent also provided estimates of total household income in the prior year and the family's current

net worth. These variables are logged in analysis. Finally, we include a family structure variable indicating whether the respondent comes from an intact family (1=intact, 0=non-intact). Descriptive statistics, by educational outcome, for all variables used in analysis are located in table 1.

[Table 1 about Here]

Most variables had either no or small amounts of missing data (1-2%). However, some variables had a significant amount of missing values. Among these are household income and wealth (26% each), father's education (20%), and the ASVAB score (21%). Missing data were imputed via multiple imputation (Rubin 1987) using the ICE command in Stata (Royston 2005). ICE uses a chained equations approach in which, for each variable, a conditional distribution for missing data, given all other data, is specified (logit for dichotomous variables, OLS for continuous variables). It is then assumed that these conditional distributions are derived from an underlying multivariate distribution. Iterative draws from the conditional distribution using Gibbs sampling generates the multivariate distribution from which imputed values are then drawn (van Buuren, Boshuizen, and Knook 1999). Imputation-specific logistic regression results are then pooled using the micombine procedure.

Analysis

Analyses are first conducted using multivariate logistic regression. For both timely high school completion and post-secondary enrollment a series of nested models were estimated. Model 1 estimates the association educational attainment while controlling for the demographic background. Model 2 adds family structure and parental socioeconomic status. Model 3 then adds health status to test if for a significant health gradient in

educational outcomes net of social background. Model 4 then adds the measures of academic achievement as mediators. Model 5 then includes the measures of psychosocial peer/school relations. Finally, the full model (model 6), controls demographic and socioeconomic background, academic achievement, and psychosocial peer/school relations. Analyses correct for the complex sampling design employed in the NLSY97 using the svylogit command in Stata.

Because the NLSY97 includes a number of sibling sets we also estimated multivariate sibling fixed-effect (conditional logit) models in order to account for unobserved heterogeneity at the family level. By conditioning on family of origin, these models have the effect of comparing the educational attainment of siblings that differ in their initial health status while controlling for all shared family background characteristics (observed and unobserved) that they share. Estimation is accomplished by including a set of family-specific dummy variables. Thus, the outcome of interest is regressed upon the predictors while including (k-1) indicator variables corresponding to k original 1997 families within which the siblings are clustered (see Jencks et al. 1972 for similar applications). This estimation utilizes one degree of freedom to estimate each of these family-specific means with one family excluded as the referent. The parameters for each individual family fixed effect are not presented as these are not of substantive interest in and of themselves. The socio-demographic profile of the sibling sample did not differ meaningfully from the general analytic samples.

RESULTS

Timely High School Completion

Table 2 presents parameter estimates from logistic regression models of timely high school completion. As model 1 indicates, males, non-Hispanic blacks, and Hispanics are less like to complete high school by their 20th birthday. Once the socioeconomic background of the adolescent is controlled for (model 2), racial differences are reduced by about half and in the case of Hispanics are completely eliminated. As would be expected those who come from families that are intact, have greater material resources (income and wealth), and have more highly educated parents, are substantially more likely to have completed high school on time. Model three adds a measure of the adolescent's average self-rated health over the first two waves. Net of demographic and socioeconomic background, those who reported being in worse health were substantially less likely to complete high school by the age of 20. A one unit decrease in health lowers the odds of timely high school completion by 34%. As predicted, when measures of academic achievement are added as mediators (model 4) the association between adolescent health and high school completion is reduced (by half) but remains large and statistically significant. In this model, a one unit decrease in health is associated with 17% reduced odds of completing high school. This would suggest that a significant portion of the differential high school completion by adolescent health status is mediated by academic performance. In addition, after controlling for academic achievement, non-Hispanic blacks are now 41% more likely than non-Hispanic whites to complete high school. When controls for psychosocial relations with peers are included (model 5), the association between health and high school completion is attenuated only slightly (6%). In the full model (model 6), which includes both academic achievement and psychosocial peer/school relations the effect of health on high school completion remains. A one unit

decrease in health is associated with 16% reduced odds of completing high school in a timely fashion.

[Table 2 about here]

Table 3 presents estimates from the sibling fixed-effects model of timely high school completion. The results are very similar to those in the standard model. Those who report worse health are substantially less likely to complete high school by their 20th birthday than are their healthier siblings. A one unit decrease in health is associated with 35% lower odds of timely high school completion. The addition of academic achievement and psychosocial peer/school relations does not appreciably alter this estimate. Thus the within-family analysis suggests that the association between health and timely high school completion is not mediated by academic performance or relations with peers. Nor does this association appear to result from stable unobserved factors that cause some adolescents to have both worse health and diminished educational attainment.

[Table 3 about here]

Post-Secondary Enrollment

Table 4 presents estimates from logistic regression models of post-secondary enrollment. As with timely high school completion, males, blacks, and Hispanics are less likely to continue their schooling beyond high school (model 1). However, after controlling for family socioeconomic circumstances (model 2), blacks are as likely, and Hispanics 32% more likely, to enroll in post-secondary schooling as their non-Hispanic white peers. As shown in model 3, there is also a large and statistically significant effect of health on the probability of pursuing post-secondary education. Net of demographic and socioeconomic background, a one unit decrease in health is associated with 30% lower

odds of post-secondary enrollment. The addition of measures of academic achievement substantially reduces the estimated association between health and post-secondary education (model 4). The estimated impact of a one-unit change in health is reduced by about one-third. However, this association remains large and statistically significant. We also find that after controlling for prior academic achievement blacks and Hispanics are 78% and 59%, respectively, more likely than their white peers to extend their schooling after high school. As was the case with high school completion, controlling for psychosocial peer/school relations (model 5) only attenuates the impact of health on post-secondary enrollment only slightly (6.7%). In the full model (model 6), the effect of health on post-secondary enrollment remains. A one unit decrease in health is associated with 16% reduced odds of continuing schooling beyond high school.

[Table 4 about here]

To account for the influence of unobserved heterogeneity on the association between health and post-secondary schooling, we estimate sibling fixed-effects estimates of this association (table 5). In the within-family models of post-secondary enrollment we find that those who report worse health are less likely than their healthy siblings to continue their schooling. A one-unit decrease in health is associated with 21% lower odds of post-secondary enrollment. However, this difference is also completely mediated by prior academic achievement and psychosocial relations with peers. Thus net of stable unobserved family factors there does not appear to be a significant relationship between health in adolescence and the likelihood of post-secondary enrollment, conditional on having already finished high school. Poor adolescent health continues to have a negative impact on the probability of achieving the highest levels of education; however, this

appears to act exclusively through reducing the likelihood of making the critically important prior transition of successfully completing high school.

[Table 5 about here]

DISCUSSION

The preceding analysis replicates previous research documenting an adverse impact of poor health on educational attainment (Haas 2006; Case et al. 2005). It further expands this literature by exploring possible academic and psychosocial mechanisms underlying this association. We find that health gradients in educational attainment are quite large in adolescence and early adulthood. Adolescents experiencing poor health are substantially less likely to make the important educational transitions of high school completion and post-secondary enrollment. Such transitions are critical to later occupational attainment and have lasting impacts on earnings profiles over the work career. Our results further demonstrate that both psychosocial and academic factors are important mediators between adolescent health and educational attainment in young adulthood, net of family background and socioeconomic factors. However, the results suggest that, while psychosocial factors matter, academic factors are much more important mediators of the association between health and educational attainment.

We also test whether or not the association between adolescent health and subsequent educational attainment results from unobserved heterogeneity using sibling fixed-effects models. For timely high school completion, we find that the impact of poor health remains and is in fact larger when controlling for stable unobserved family characteristics. For post-secondary enrollment we also find large and significant effects of health. However, after controlling for psychosocial and academic characteristics this

association is no longer significant. This is not to say that the sibling fixed-effect models suggest no relationship between health and post-secondary enrollment. However, the majority of the negative impact of health is acting through substantially lowered probabilities of making the requisite prior transition of completing high school.

Our analysis has some limitations. First, it is possible that health is endogenous to educational attainment. We do not have a source of exogenous variation in health status and so our models can not rule out the possibility that these associations are the result of the reverse causal process than that hypothesized above. However, this is not likely to be the case. First, it is important to point out that the presence of a significant temporal effect of adolescent health on later educational attainment does not preclude the possibility of an additional causal effect of that diminished educational attainment on subsequent health status in adulthood. In other words, the two casual processes are not necessarily mutually exclusive. Second, such issues are often associated with cross-sectional studies. However, unlike cross-sectional studies, we are observing the process of educational attainment as it unfolds. The longitudinal nature of the analysis estimating the association between health early on and educational attainment over the subsequent several years makes the logic of the reverse causal ordering temporally implausible. Another limitation is that many of our psychosocial variables were collected at the same time that health was assessed. Therefore we cannot establish the temporal ordering to make strong claims about causality. This necessarily makes our discussion of them as mediating the relationship between health and educational transitions speculative (though we would argue still informative). The assumption is that past and current psychosocial difficulties serve as a proxy for future problems.

Another limitation is that our psychosocial variables are limited in scope and only capture information about particular aspects of peer's relationships (violence and bullying). Other dimensions of peer relations are also likely to be important mediators of the impact of health on educational attainment. For example, adolescents that experience poor health may also have very different social network structures. They may have smaller networks and thus lower levels of social support to draw upon, which may further exacerbate their health problems. Peer networks are also an important determinant academic achievement. More research is needed to better understand how health may shape the structural characteristics of adolescent social networks.

Finally, it is important to point out that this sample is still relatively young. On average, the NLSY97 respondents are 14 years old at baseline and are 21 years old at the end of follow up in the present analysis. Therefore, there may be a substantial amount of censoring on the dependent variables. A fair number of those that had not completed high school by their 20th birthday may eventually do so at some point. Also, as it is not uncommon for young adults to delay college attendance or other post-secondary training, censoring is likely to be more problematic for post-secondary education than for timely high school completion which already attempts to account for the educational stragglers. However, even if those in poor health eventually catch up to the educational attainment of their healthy peers, they are still likely to experience lasting economic disadvantages. For example, even if they eventually complete high school, they are more likely to do so through earning a GED, which despite its moniker, does not confer the same labor market returns as a high school diploma (Cameron and Heckman 1993). GED recipients are also less likely to subsequently transition to a 4-year college (Horn and Carroll 1996). At the

very least, their delayed educational trajectories will prevent the adolescents from fully maximizing the labor market returns to their education, particularly as they will have fewer years from which to reap the benefits of their additional education. It is more likely that unhealthy adolescents will never catch up to their healthy peers and end up with substantially less schooling as they make the transition to the labor market.

This analysis highlights a potentially important role of health selection processes in generating socioeconomic inequalities. Respondents who report worse health in early to middle adolescence experience significant deficits in educational attainment in young adulthood, which can place them at considerable disadvantage in the labor market. As education is one of the key determinants of occupational attainment and labor market earnings (Sewell and Hauser 1975), the long term socioeconomic consequences for poor adolescent health may therefore be quite substantial. Indeed, previous analyses have shown that the adverse consequences of poor childhood and adolescent health are not confined to educational attainment, but have long-term impacts on labor market participation, occupational standing, earnings, and ultimately wealth accumulation (Haas 2006; Case et al. 2005). Future work on socioeconomic attainment and labor market inequality would be well served by better accounting for the role played by early life health status in determining the winners and losers in the stratification process.

NOTES

1. Baseline health status was not associated with subsequent sample attrition. There were substantively very small (yet statistically significant) associations between some measures of academic performance and sample attrition. Those with higher ASVAB

scores and with fewer school absences were slightly less likely to be lost to follow-up. Sample attrition was not associated with GPA or grade repetition. Household income, wealth, and family structure was also not significantly associated with sample attrition. The potential bias introduced by sample attrition is likely to be negligible.

2. We also compared those who reported consistently good health to those who reported consistently poor health and those who reported improving or declining health. As would be expected, we find a graded effect of health over time with those consistently reporting good health having the best educational outcomes and those consistently reporting poor health having the worst. Those whose health improved or declined were in the middle.

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Table 1. Descriptive Statistics of Variables Used (NLSY97)

	Non-High School Graduates (N=1280)[1]			Timely High School Graduates (N=6770)			No Post-Secondary Education (N=2357)[2]			Any Post Secondary Education (N=4631)[2]		
	%	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD
Average Self-Rated Health		2.22	0.76		1.88	0.68		2.08	0.72		1.81	0.65
Male	56.7			48.9			55.9			44.7		
Female	43.3			51.1			44.1			55.3		
Age		14.90	1.22		14.37	1.47		14.14	1.48		14.42	1.47
Non-English Speaking	22.0			20.4			21.2			20.9		
Black Non-Hispanic	36.8			24.9			32.0			22.8		
Hispanic	28.6			19.3			24.1			17.2		
White Non-Hispanic	34.5			55.7			43.8			59.9		
Household Income (log$)		9.58	1.43		10.44	1.16		9.94	1.27		10.62	1.09
Household Wealth (log$)		7.70	5.19		9.56	4.83		8.38	5.17		10.03	4.65
Mother's Education		10.95	2.59		12.83	2.86		11.52	2.63		13.37	2.88
Father's Education		10.76	2.91		12.94	3.12		11.42	2.86		13.57	3.13
Intact Family Structure	25.5			54.3			38.9			60.1		
Learning Problem	19.4			7.8			15.9			5.5		
ASVAB (Percentile)		19.40	18.52		51.18	28.08		30.32	24.13		59.49	26.39
Ever Repeated a Grade	44.0			11.1			27.5			6.7		
Number of School Absences		8.77	11.98		4.10	6.10		5.75	8.85		3.66	4.85
GPA		2.18	0.78		2.95	0.80		2.41	0.80		3.18	0.73
Feel Safe in School	74.1			88.2			79.8			90.7		
Threatened to be Hurt	26.8			19.1			27.1			15.6		
Physical Altercation	32.2			13.5			24.4			9.5		
Victim of Repeated Bullying	12.4			10.5			11.3			10.2		

[1] Did not complete high school by age 20

[2] Among those who ever completed high school

Table 2. Logistic Regression of Timely High School Completion NLSY97: 1997-2003 (Odds-Ratios)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Male	0.72***	0.65***	0.59***	0.81*	0.65***	0.85
	(0.64-0.82)	(0.56-0.75)	(0.51-0.68)	(0.69-0.96)	(0.56-0.76)	(0.72-1.01)
Non-English Speaking	1.18	1.12	1.12	1.14	1.12	1.13
	(0.99-1.40)	(0.93-1.36)	(0.92-1.36)	(0.93-1.40)	(0.92-1.36)	(0.93-1.40)
Non-Hispanic Black	0.42***	0.82*	0.79**	1.41***	0.86	1.45***
	(0.36-0.49)	(0.69-0.97)	(0.67-0.94)	(1.15-1.72)	(0.72-1.02)	(1.18-1.78)
Hispanic	0.39***	1.06	1.05	1.16	1.06	1.15
	(0.33-0.46)	(0.85-1.31)	(0.85-1.31)	(0.91-1.48)	(0.85-1.32)	(0.90-1.47)
Age	0.96	0.96	0.96	1.01	0.94*	0.99
	(0.91-1.01)	(0.91-1.02)	(0.91-1.02)	(0.95-1.07)	(0.89-0.99)	(0.93-1.06)
Income (log$)		1.27***	1.26***	1.17***	1.24***	1.16***
		(1.18-1.36)	(1.17-1.36)	(1.08-1.28)	(1.15-1.34)	(1.07-1.27)
Net Worth (log$)		1.03***	1.02**	1.02*	1.02**	1.02
		(1.01-1.04)	(1.01-1.04)	(1.00-1.03)	(1.00-1.04)	(1.00-1.03)
Father's Education		1.12***	1.11***	1.05*	1.10***	1.05*
		(1.08-1.15)	(1.07-1.15)	(1.01-1.09)	(1.06-1.14)	(1.01-1.09)
Mother's Education		1.13***	1.13***	1.08***	1.13***	1.08***
		(1.10-1.17)	(1.09-1.17)	(1.04-1.12)	(1.09-1.17)	(1.04-1.13)
Intact Family		2.43***	2.32***	1.93***	2.21***	1.90***
		(2.06-2.87)	(1.96-2.74)	(1.61-2.31)	(1.87-2.62)	(1.58-2.28)
Self-Rated Health			0.66***	0.83***	0.68***	0.84***
			(0.60-0.72)	(0.75-0.92)	(0.62-0.75)	(0.75-0.93)
ASVAB (percentile)				1.03***		1.03***
				(1.03-1.04)		(1.02-1.04)
GPA				1.72***		1.70***
				(1.53-1.92)		(1.51-1.90)
Ever Repeated a Grade				0.48***		0.48***
				(0.40-0.57)		(0.40-0.59)
Number of School Absences				0.96***		0.97***
				(0.95-0.97)		(0.95-0.99)
Emotional Problem				0.89		0.92
				(0.68-1.15)		(0.71-1.20)
Feel Safe in School					1.69***	1.29*
					(1.41-2.02)	(1.05-1.57)
Threatened to be Hurt					0.98	0.99
					(0.82-1.17)	(0.81-1.21)
Physical Altercation					0.46***	0.63***
					(0.39-0.55)	(0.52-0.77)
Victim of Bullying					1.05	0.93
					(0.84-1.30)	(0.73-1.18)
Observations	8050	8050	8050	8050	8050	8050

Robust 95% confidence intervals in parentheses

* $P<.05$; ** $P<.01$; *** P<.001

Table 3. Sibling Fixed Effects Model of Timely High School Completion (NLSY97)

	Model 1	Model 2	Model 3	Model 4	Model 5
Male	0.59**	0.53***	0.73	0.58**	0.81
	(0.42-0.84)	(0.37-0.77)	(0.47-1.14)	(0.40-0.86)	(0.51-1.28)
Age	0.99	0.98	0.94	0.95	0.91
	(0.87-1.13)	(0.85-1.12)	(0.80-1.10)	(0.82-1.09)	(0.76-1.08)
Self-Rated health		0.65***	0.66**	0.65**	0.66**
		(0.50-0.84)	(0.49-0.91)	(0.50-0.85)	(0.48-0.91)
ASVAB (percentile)			1.03***		1.03***
			(1.01-1.04)		(1.01-1.04)
GPA			1.98***		2.03***
			(1.45-2.72)		(1.46-2.81)
Ever Repeated a Grade			0.66		0.64
			(0.38-1.17)		(0.36-1.13)
Number of School Absences			0.99		0.99
			(0.96-1.02)		(0.96-1.02)
Emotional Problem			0.94		0.94
			(0.43-2.07)		(0.41-2.14)
Feel Safe in School				1.27	1.03
				(0.80-2.04)	(0.58-1.82)
Threatened to be Hurt				0.88	0.83
				(0.54-1.43)	(0.46-1.50)
Physical Altercation				0.61*	0.61
				(0.38-0.98)	(0.36-1.03)
Victim of Bullying				1.19	1.42
				(0.65-2.16)	(0.71-2.85)
Observations	2777	2777	2777	2777	2777

Robust 95% confidence intervals in parentheses
* $P<.05$; ** $P<.01$; *** $P<.001$

Table 4. Logistic Regression of Post Secondary Enrollment NLSY97: 1997-2003 (Odds-Ratios)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Male	0.61***	0.55***	0.51***	0.64***	0.54***	0.66***
	(0.55-0.68)	(0.49-0.61)	(0.45-0.57)	(0.57-0.73)	(0.48-0.60)	(0.58-0.74)
Non-English Speaking	1.33***	1.33***	1.34***	1.46***	1.36***	1.48***
	(1.15-1.55)	(1.12-1.59)	(1.12-1.60)	(1.20-1.77)	(1.14-1.63)	(1.22-1.79)
Black Non-Hispanic	0.63***	1.03	1.02	1.78***	1.07	1.79***
	(0.55-0.72)	(0.88-1.20)	(0.88-1.19)	(1.48-2.13)	(0.91-1.24)	(1.49-2.15)
Hispanic	0.56***	1.32**	1.33**	1.59***	1.30*	1.55***
	(0.48-0.66)	(1.07-1.63)	(1.08-1.63)	(1.26-1.99)	(1.05-1.60)	(1.23-1.94)
Age	1.11***	1.13***	1.13***	1.18***	1.12***	1.17***
	(1.06-1.15)	(1.08-1.18)	(1.08-1.18)	(1.12-1.24)	(1.07-1.17)	(1.12-1.23)
Income (log$)		1.15***	1.15***	1.11*	1.15***	1.11*
		(1.07-1.25)	(1.07-1.24)	(1.02- 1.20)	(1.06-1.24)	(1.02- 1.20)
Net Worth (log$)		1.03***	1.02**	1.02*	1.02**	1.02*
		(1.01-1.04)	(1.01-1.04)	(1.00-1.04)	(1.01-1.04)	(1.00-1.03)
Father's Education		1.13***	1.12***	1.07***	1.12***	1.07***
		(1.09-1.16)	(1.09-1.15)	(1.03-1.11)	(1.08-1.15)	(1.03-1.11)
Mother's Education		1.12***	1.12***	1.08***	1.12***	1.08***
		(1.09-1.16)	(1.09-1.15)	(1.05-1.12)	(1.09-1.15)	(1.05-1.12)
Intact Family		1.46***	1.42***	1.25**	1.34***	1.21*
		(1.27-1.67)	(1.23-1.62)	(1.07-1.46)	(1.17-1.54)	(1.04-1.42)
Self-Rated Health			0.70***	0.82***	0.72***	0.84***
			(0.64-0.76)	(0.75-0.91)	(0.67-0.79)	(0.76-0.92)
ASVAB (percentile)				1.02***		1.02***
				(1.02-1.03)		(1.02-1.03)
GPA				1.87***		1.84***
				(1.70-2.05)		(1.67-2.03)
Ever Repeated a Grade				0.62***		0.62***
				(0.49-0.77)		(0.50-0.78)
Number of School Absences				0.98**		0.98*
				(0.97-0.99)		(0.97-0.99)
Emotional Problem				0.80*		0.84
				(0.64-1.00)		(0.67-1.06)
Feel Safe in School					1.40***	1.18
					(1.16-1.69)	(0.96-1.45)
Threatened to be Hurt					0.71***	0.75***
					(0.60-0.83)	(0.62-0.89)
Physical Altercation					0.69***	0.87
					(0.57-0.84)	(0.69-1.08)
Victim of Bullying					0.96	0.88
					(0.79-1.17)	(0.71-1.09)
Observations	6988	6988	6988	6988	6988	6988

Robust 95% confidence intervals in parentheses
* *P* <.05; ** *P* <.01; *** P<.001

Table 5. Sibling Fixed Effects Model of Post Secondary Enrollment (NLSY97)

	Model 1	Model 2	Model 3	Model 4	Model 5
Male	0.52***	0.48***	0.54***	0.50***	0.49***
	(0.38-0.70)	(0.36-0.66)	(0.38-0.76)	(0.36-0.68)	(0.36-0.67)
Age	1.18***	1.19***	1.19***	1.21***	1.21***
	(1.08-1.30)	(1.08-1.30)	(1.07-1.33)	(1.09-1.34)	(1.08-1.36)
Self-Rated health		0.79*	0.88	0.81	0.89
		(0.63-0.99)	(0.68-1.14)	(0.64- 1.02)	(0.69-1.17)
ASVAB (percentile)			1.02***		1.02***
			(1.01-1.03)		(1.01-1.03)
GPA			1.70***		1.70***
			(1.30-2.22)		(1.29-2.24)
Ever Repeated a Grade			1.03		1.01
			(0.58-1.83)		(0.57-1.80)
Number of School Absences			0.98		0.98
			(0.94-1.01)		(0.94-1.02)
Emotional Problem			0.81		0.91
			(0.55-1.54)		(0.47-1.73)
Feel Safe in School				1.83*	1.99*
				(1.08-3.13)	(1.07-3.68)
Threatened to be Hurt				0.80	0.75
				(0.53-1.21)	(0.47- 1.20)
Physical Altercation				0.86	1.34
				(0.52-1.41)	(0.75-2.41)
Victim of Bullying				0.69	0.80
				(0.41-1.15)	(0.45-1.40)
Observations	2597	2597	2597	2597	2597

Robust 95% confidence intervals in parentheses
* $P<.05$; ** $P<.01$; *** $P<.001$