Schools, skills, and self-rated health:
A test of conventional social science wisdom on education and health

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ABSTRACT

Conventional wisdom on educational attainment and health emphasizes a human capital perspective with expectations of a quasi-linear association with large effects for high levels of educational attainment that are reasonably robust to typically measured and unmeasured explanatory factors. This paper challenges this wisdom by offering an alternative theoretical account and empirical investigation organized around the role of measured and unmeasured cognitive and non-cognitive abilities as confounders in the association between educational attainment and health. Based on data from the National Longitudinal Survey of Youth – 1997, results indicate that a) effects of educational attainment are uniquely vulnerable to issues of omitted variable bias; b) that measured indicators of cognitive and non-cognitive abilities account for a significant proportion of the traditionally observed effect of educational attainment; c) that such abilities have effects larger than that of even the highest levels of educational attainment when appropriate controls for unmeasured heterogeneity are incorporated; and d) that models that most stringently control for such time-stable abilities show little evidence of a substantive association between educational attainment and health. Implications for theory and research are discussed.

The relationship between education and health has been a centerpiece of sociological study for over a century. It exists as one of a few aspects of socioeconomic status that is viewed as a "fundamental cause" of health and health disparities (Link and Phelan 1995). Research both across time and across the globe routinely finds that those with higher educational attainment report better health (Ross and Wu 1995; Subramanian, Huijts, and Avendano 2010), have lower risk of chronic disease (Winkleby, Jatulis, Frank and Fortmann 1992), have lower risk of a variety of cancers (Jemal et al. 2008), and live longer (Kitagawa and Hauser 1973; Rogers, Everett, Zajacova, and Hummer 2010). Moreover, there have been recent claims that educational differences in health and mortality are increasing over time (Goesling 2007; Liu and Hummer 2008; Montez et al 2011; Mirowsky and Ross 2008). Equally profound, education was recently singled out as one of a limited number of "social" causes for excess mortality in the United States, where low education is estimated to produce approximately 245,000 deaths in the US in 2000 alone (Galea et al 2011). With such widespread empirical support, important public policy statements have emerged that view "education policy" as an important element of "health policy" (Conti, Heckman, and Urzua 2010; Hayward 2012; Schoeni, House, Kaplan and Pollack 2008).

In sociology and most other social sciences, the prevailing view is that education has a causal effect on health with either direct or indirect reference to the role of human capital accumulation in the production of health dynamics (e.g., Cutler and Lleras-Muney 2008; Link and Phelan 1995; Mirowsky and Ross 1998). Large effect sizes, linear relationships across categories of educational achievement, (reasonable) statistical explanation when proximal causes of health (e.g., behavioral risk factors such as smoking, poor diet, lack of exercise and a resulting high body mass index) are controlled, yet (reasonably) large residual effect sizes that are often comparable in magnitude to those of said risk factors, buttress arguments that education is a key cause, with multifaceted pathways, of health (Mirowsky and Ross 2003; Montez, Hayward, and Hummer 2012; Ross and Mirowsky 1999; Ross and Wu 1995). Given this, research has tended to view educational attainment as a fundamental predictor of health (Braveman, Egerter, and Williams 2011; Cutler, Lleras-Muney and Vogl 2008; Link and Phelan 1995; Miech, Pampel, Kim, and Rogers 2011) and has emphasized the need to understand the mechanisms by which education influences health (Mirowsky and Ross 2003; Ross and Wu 1995). In some circles, questions have been raised about the possibility of spuriousness (Behrman et al. 2011; Fujiwara and Kawachi 2009; Lleras-Muney 2005), but such concerns have seldom offered a compelling alternative to the human capital explanation and have had limited impact upon sociological research on health and health disparities (see discussions in Braveman et al. 2011; Cutler and Lleras-Muney 2008; Marmot and Wilkinson 2005; Mirowsky and Ross 2003).

In this study, we juxtapose two different ideas about the meaning of education and re-examine its association with health. As noted, the conventional view is a human capital model where educational attainment increases access to resources and knowledge that translate into better capability for management of health dynamics, dynamics that include the mitigation of risks and the utilization of health care technologies when health problems emerge (e.g., Link and Phelan 1995; Miech et al. 2011; Mirowsky and Ross 2003; Ross and Wu 1995). An alternative view builds upon key themes in life course sociology and emphasizes the cumulative nature of social life and the importance of age-graded social and psychological development as a necessary basis for producing subsequent experiences and achievements in the unfolding life course. In the realm of educational attainment, such a perspective highlights the importance of early skill development, the formation of reasonably stable cognitive and non-cognitive abilities, and how these introduce endogeneity in processes of educational attainment. From this perspective, educational attainment is the product of self-reinforcing and complementary processes whereby earlier skills generate later skills, where successful skill attainment in one domain (e.g., cognitive abilities) fosters skill attainments in other domains (e.g., non-cognitive skills such as patience, persistence, self-control) and where resulting stocks of abilities are the engines of educational achievement and progressive attainment over the life course (e.g., Alexander, Entwisle and Horsey, 1997; Carneiro, Crawford, and Goodman 2007; Cunha et al 2006; Entwisle, Alexander and Olson 2005; Farkas et al. 1990; Heckman 2006, 2008). Importantly, such abilities are almost never measured or modeled in health research, are hence "unobserved" in prior work, and may distort conclusions about the significance of educational attainment for health given widely accepted principles of omitted variable bias. Research that statistically accounts for such factors, directly or indirectly, would empirically evaluate the strength of causal claims around education and health in innovative and novel ways and would advance theoretical understanding in the sociology of health and social epidemiology by adjudicating between the different perspectives on education and health.

In this paper, we use data from the National Longitudinal Survey of Youth 1997 to further examine the relationship between skills, schooling, and health. To our knowledge, these data are unique in that the multi-panel structure includes annual measures of educational attainment and health that allows estimation of models that assess the effects of *change in education* on *change in health* that are the basis of random- and fixed-effects estimation and that control, in different ways, for time-stable, unobserved characteristics of individuals that confound the causal effect of education on health. These data also include credible measures of cognitive and non-cognitive traits that are critically important in evaluating the meaning of the education-health relationship. In general, these data can harness the power of longitudinal data for better estimation of causal effects (Allison 2009; Baltagi 2005; Greene 2011; Halaby 2004) and have important statistical advantages over traditional ordinary least squares approaches that characterize prior sociological research. They also allow for a direct and indirect consideration of the importance of the stock of time-stable cognitive and non-cognitive abilities on health dynamics.

Our research has five key dimensions. First, all analyses begin by replicating the conventional association between educational attainment and self-rated health using a conventional (OLS) regression-based approach that, in various guises, is the basis of sociological research on educational gradients in health. Second, we use maximum likelihood, random-effects estimation (ML-RE) to examine the joint effects of educational attainment and cognitive and non-cognitive abilities on health. These models have the advantage of exerting stronger controls for unmeasured heterogeneity, while also allowing for the estimation of associations between time-invariant factors such as cognitive and non-cognitive traits in adolescence and time-varying health. Third, we further examine the association between educational attainment and health using maximum likelihood, fixed-effect (ML-FE) models that effectively net out all time-stable unobserved heterogeneity, including previously modeled cognitive and non-cognitive traits, and hence provide an even more stringent assessment of the importance of unmeasured time-stable traits and, by extension, the causal effect of education on health. Fourth, we estimate all models with and without controls for a large number of time-varying factors that are widely regarded as proximal determinants of health (e.g., body mass, smoking, substance use) and can reasonably be viewed as other behavioral indicators of non-cognitive traits. These latter models also provide points of comparison in assessing the significance, statistical and substantive, of the educational effects, with the different specifications. Finally, for all analyses, we assess robustness of conclusions for six race-sex groups.

EDUCATION AS A CAUSE OF HEALTH: A HUMAN CAPITAL PERSPECTIVE

Prevailing sociological, (most) epidemiological, and medical science accounts of education and health stress a causal relationship where increases in educational attainment produce better health outcomes. In such work, education is viewed as an engine of human capital acquisition that has transformative consequences for a diverse set of psychological and social behaviors and experiences (see Becker 2009 for a general discussion). From a human capital perspective, education increases the stock of competencies, general and specific knowledge, and a variety of personal and social attributes that increases one's ability to function successfully within both market and non-market environments. Importantly, human capital derived from education has market value and is a key component of selection and allocation dynamics for occupational attainment and mobility and for resulting compensation and wealth accumulation (Blau and Duncan 1967; Hauser and Warren 1997).

A human capital perspective on education and health is particularly clear in Link and Phelan's (1995) articulation of "fundamental causes." As a fundamental cause, education increases access to money, knowledge, power, and prestige and enables people to avoid disease and other negative health consequences by placing them in a better position to act on information and to make behavior changes (Link and Phelan 1995). Even as the profile of major diseases and chronic conditions affecting a society change over time, individuals in better social and economic positions should be advantaged in dealing with contemporary and emerging conditions of risk (Link and Phelan 1995; Miech et al. 2011; Warren and Hernandez 2007).

A human capital perspective on educational attainment proposes several mechanisms in the causal relationship between education and health. To start, educational attainment increases learned effectiveness, including greater self-esteem and self-efficacy, and increases capacity for critical thinking skills and decision-making that assist in medication adherence, reading and understanding of medical information, and evaluation of complex and new health treatments and medical science and technology (Cutler and Lleras-Muney 2008; Mirowsky and Ross 2003; Ross and Wu 1995). Via learned effectiveness, greater educational attainment is further linked to better navigation of health care systems, identification of more knowledgeable and skilled medical providers, and retention of medical information during health care encounters (Hummer and Lariscy 2011).

Education also helps one to avoid risky situations and to exit risky situations faster, imparting knowledge, motivation and discipline to adopt healthy practices, and facilitating resource substitution when faced with adversity (Mirowsky and Ross 2003; Ross and Wu 1995). Adoption of a healthy lifestyle, including drinking in moderation, avoidance of tobacco or smoking cessation, avoiding recreational drugs, and maintenance of a healthy weight through diet and physical activity, defends against a broad range of diseases and impairments. Through practical and creative adaptation, personal control buffers against threats and the potential detrimental impact of adversities such as economic hardship and neighborhood disorder.

Education also helps create and maintain supportive and healthy relationships (Mirowsky and Ross 2003). Supportive relationships assist in coping and dampen the impact of events and experiences in which self-esteem and perceptions of control are threatened (Pearlin and Schooler 1978). Beyond support, relationships further provide important metrics for behavior. Those more highly educated are also more likely to have highly educated friends and partners who may in turn place greater value on health and act more healthfully (Cutler and Lleras-Muney 2008). This may result in greater personal accountability and discouragement of negative health behaviors.

As a final mechanism, education facilitates the acquisition of work that is of personal and practical value in promoting health (Mirowsky and Ross 2003). More education results in greater likelihood of work that provides the means to obtain basic human needs (e.g. food, water, shelter), as well as supports social and psychological needs, such as belongingness, competence and achievement, and esteem (Maslow 1943). Greater educational attainment further improves labor market experiences, including acquisition of more secure, more stable, and higher status jobs (Cutler and Lleras-Muney 2008; Reynolds and Ross 1998), jobs which are more likely to offer extrinsic benefit such as good pay, health insurance and retirement benefits. Thus, educational attainment results in greater capacity for increasing income, assets, and wealth that facilitate the “purchase” of a variety of health enhancing commodities.

EDUCATION AS ENDOGENOUS: EDUCATIONAL ATTAINMENT AS LIFE COURSE CONTINGENT

An alternative to the human capital model of educational attainment with contrasting implications for its association with health emphasizes temporality in the life course and the importance of contingent relationships among life course experiences and attainments. A central concept in life course social science is the idea of social trajectories that refer to the institutional pathways that individuals follow, through education, through work, through family, that characterize the sum of experience (Elder 1998). Such trajectories are intertwined with life course transitions, entering or exiting school, getting a job, quitting a job, getting married, having children, that give them unique meaning and form and situate them both within the age-graded life span and within unique sociohistorical contexts (Elder 1985). Within trajectories, there is also movement between qualitatively different states that in some cases are hierarchically defined. For example, work careers can involve movement between firms or movement within positions with firms as a mechanism of mobility and the factors that drive the character and content of such processes may vary dramatically depending upon the type of mobility (Rosenfeld 1992). Similarly, trajectories of education, a point we return to with greater detail, are not simply movement between key stages (i.e., elementary school, middle school, high school, college), but involve experiences of grades, of curricula, and of tracks, that give them unique meaning and direction (Gamoran 1987). Given the shifting and multiplicity of contexts, human agency is a fundamental aspect of the perspective and emphasizes the role of decision and choice, bounded by psychosocial circumstances (Shanahan 2000), in shaping the nature and content of social trajectories and in doing so producing future achievements and experiences (Emirbayer and Mische 1998).

Importantly, an emphasis on social trajectories and agency highlight the important element of *life course contingency*. Life course contingency centralizes time in the organization of the life course and emphasizes the connections between different life course events and attainments. While neither theory or research has been particular precise about the mechanics of such contingencies, different social structures and the institutional environments that they generate embody schema and resources that structures the nature and progress of activity within them (Sewell 1992). When one considers action within this framework, the enactment of life course schema, enactments that propel people over the age-span, often require resources, personal, social, and material, that makes such enactments probable. A life course contingency perspective emphasizes the idea that certain social and psychological phenomena are necessary or probabilistic precursors to subsequent experiences and attainments. Nowhere is this clearer than in analyses of educational careers.

Educational institutions are intensely hierarchical and select on prior achievements to determine advancement up the hierarchy. Even in the earliest years, students need to demonstrate (even if only a minimal threshold of) mastery with respect to cognitive, psychological, and social skills to warrant (or activate) promotion (Alexander, Entwisle, and Dauber 1993). With advancing stages, curricula become more defined and the requirements for promotion more standardized and universal, typically having a basis in internal or external testing. Test scores are, depending upon one's view of them, either an indicator of cumulative achievements that signal preparation for subsequent educational promotion or a sorting mechanism whereby institutions manage the stock and flow of people across stages. Moreover, the institutionalization of education has an added feature of general stages, primary, secondary, post-secondary, graduate, post-graduate, where there is even more explicit benchmarking of prior achievements and increasingly additional, targeted testing, as the sorting mechanism for entrance into subsequent stages.

In understanding movement through and across educational institutions, there is increased attention to the notion of "skills" as the fundament driver of the dynamics of educational attainment. Skills can be differentiated into those cognitive and those non-cognitive (Carneiro, Crawford, and Goodman 2007; Farkas 2003; Heckman 2006). Cognitive skills are typically conceptualized as a generalized ability to process information and to problem solve whether it involves comprehension, computation, or strategic and goal oriented applications of rules (e.g., algebra, geometry, or calculus). In contrast, non-cognitive skills embody issues of effort, organization, and discipline, as well as leadership, sociability, emotionality, aggressiveness, and ability to defer gratification. A key question for research is the (differential) investments that families and other social institutions make and how this reflects and reproduces inequalities in societies, including educational inequalities (Farkas 2003).

The traditional view of investments and skill formation in sociology, including much life course sociology (e.g., Elder 1994; Sampson and Laub 1993), views investments and acquisitions at different ages are reasonable substitutes for one another. From this perspective, it does not matter whether investments occur earlier or later and skills can be realized with reasonably similar likelihood and ease at different stages of the life course. In contrast, a life course contingency perspective emphasizes the sequential nature of developmental stages. Here, the likelihood of given life stage attainments is heavily dependent on attainments at earlier stages. In education and social mobility research, recent work has highlighted the importance of early skill acquisition and the critical impact of such skills on the progression of educational careers. Alexander and Entwisle, for example, in a number of important papers highlight the significance of beginning school transitions for long-term educational stratification. In summarizing much of their work, they (Entwisle and Alexander 1993: 404) write

> …the transition into full-time schooling – entry into first grade - constitutes a "critical" period for children's academic development. First, the early schooling period coincides with important cognitive changes as children shift from preoperational to operational modes of thought. Second, the elementary years, and especially first grade, constitute a special time for acquiring the basic skills of literacy and numeracy, and failing to acquire skills during this time leads to an almost insurmountable handicap.

Here, timing is a key issue and the best evidence indicates that there exist critical or sensitive periods in child development early in life where certain skills are more readily acquired. Moreover, if skills are not developed, it becomes quite difficult for subsequent acquisition. There is extensive work showing significant social differences in both cognitive and non-cognitive traits at the point of school entry as well as profound developmental blocks that exist when early skills are not formed (see reviews in Cuhna et al. 2006; Alexander, Entwisle, Blyth, and McAdoo 1988; Gottfredson and Hirschi 1990). For the former, studies using the Early Development Instrument (EDI) show significant variation in school readiness among kindergarten children in Canada, including social knowledge and competence, language and cognitive development, and communication skills and general knowledge (Janus and Duku 2007; see also Alexander, Entwisle, and Dauber 1993; Doherty 1997; Entwisle and Alexander 1992; Fryer and Levitt 2004; Lee and Burkam 2002). As an example of the latter, Rutter and colleagues (2006) compared severely deprived children from Romanian orphanages with similarly aged UK adoptees and found that those who experienced deprivation into early childhood had much poorer psycho-social development in later childhood and the preteen years compared with those adopted in infancy and who subsequently experienced a richer early childhood (Rutter, Kreppner, and O'Connor 2001; see also, Beckett et al. 2006 on cognitive abilities; Gottfredson and Hirschi 1990 on self-control; Newport 2002 on language; Spitz 1986 on intelligence). As a general conclusion, early investments that produce early skills and abilities are critical to wide ranging social and psychological development.

As noted, the bundles of attributes or personal resources that are fundamental drivers of educational attainment are usefully partitioned into those cognitive and non-cognitive, even although they are often strongly correlated. The latter reflects the fact that early investments, typically well prior to the teenage years, initiate a process of self-productivity and dynamic complementarity (Cunha and Heckman 2007). Here, initial investments and early skill formation are necessary conditions for subsequent skill formation. Skills are self-reinforcing so that skills persist from one period to the next and more skills in one period either produce or enhance skill acquisition in subsequent periods (Cunha and Heckman 2006; Cunha, Heckman, Lochner, and Materov 2006). In the realm of cognitive abilities, learning new things is easier for some than for others depending upon learning skills acquired at an earlier stage and early stocks of skills thus make agents more likely to invest in the further cultivation of skills. Skills also have dynamic complementarity in that skills in one domain are productive of skill acquisition in other domains. Cognitive ability (e.g., IQ) for example should foster non-cognitive skills (e.g., patience, persistence, self-control) by decreasing frustration and dissonance in learning processes. Consistent with this, cognitive skills are correlated strongly with work habits (e.g., doing homework, class participation, effort, and organization), as well as even more subtle indicators of non-cognitive skills such as appearance and dress (Farkas et al. 1990).

This model of self-productivity and dynamic complementarity in the acquisition of cognitive and non-cognitive skills highlights endogeneity in school achievements and educational attainment. From this perspective, educational achievements, including test scores and overall attainment, are largely a function of cognitive and non-cognitive skills that are established early in life. Empirical evidence on this is strong. McCoy and Reynolds (1999), for example, studied grade retention prior to middle school in the Chicago Longitudinal Study and found that early school performance, test scores and marks, were the strongest predictors of grade retention with further, independent, associations with poorer school performance and subsequent attainment (see also Reynolds 1992). Similarly, Farkas and colleagues' (1990) study of seventh- and eighth-grade students in the US also found that both cognitive and non-cognitive skills, the latter which they call 'cultural resources,' had extremely large effects on course work mastery and course grades, effects that were larger than the effects of sex, race, and family income combined. Consistent with this, Carneiro, Crawford and Goodman's (2007) analysis of data from the UK National Child Development Survey showed large effects of cognitive (i.e., test results for arithmetic, reading comprehension, copying, and pattern recognition) and non-cognitive (e.g., fooling around, risk-taking, hostility, inattentiveness, withdrawal) traits measured at age 11 on continuity of schooling past age 16 measured at age 23 and highest educational qualification by age 42. Perhaps most impressive, Entwisle, Alexander, and Olson's (2005) study of students in Baltimore public schools followed from first grade until age 22 found that both CAT scores and marks in reading and math in grade one were significant predictors of obtaining a college degree in later life and that a composite indicator of temperament was both strongly correlated with such indicators of cognitive abilities and was an independent predictor of overall educational attainment in early adulthood. Numerous other studies indicate the overwhelming importance of cognitive (see Beckett et al. 2006; Doherty 1997; Fryer and Levitt 2004; Janus and Duku 2007; Lee and Burkam 2002) and non-cognitive skills (see Evans et al. 1997; Gottfredson and Hirschi 1990; Harris and Robinson 2007; Tach and Farkas 2006) for educational achievements.

The conclusion that cognitive and non-cognitive abilities established early in life are fundamental drivers of educational performance and attainment raises questions about how one should interpret the meaning of the standard indicators of educational attainments (e.g., grade promotion, degree completion, and total years of education) that are typical in socio-health research. A life course contingency perspective highlights stocks of skills, cognitive and non-cognitive, that are formed early in life or in the first few years of formal education and how these coalesce into defined abilities that drive educational attainment deep into the life course. First, *there are strong conceptual links between cognitive and non-cognitive abilities and health dynamics by virtue of links to psychological affect, risk-behaviors, and socio-economic status that are the theoretical underpinnings of health dynamics over the life course*. Stronger cognitive ability allows for the better and faster processing of health-related information and for better ability to problem solve. Similarly, the conceptualization of non-cognitive abilities (e.g., self control) map closely onto various orientations towards risk and risk aversion that have clear relevance for understanding what health risks that people are exposed to and how they respond to such risks (Caspi et al. 1997). Second, and derivative, *properly measured or modeled cognitive and non-cognitive skills should have strong associations with health, even in the face of measured educational attainment*. Third, *cognitive and non-cognitive abilities that are formed early in the life course and the measures and models traditionally used in contemporary sociological health research make the stock of such abilities time-stable, unmeasured attributes in research that examines health at any point past mid-adolescence*. Here, one does not need to accept that key skill formation occurs in early life and prior to school entry (cf. Heckman 2006) and instead could simply assume that key skill formation solidifies at any time before the initial point of educational stratification, typically high school completion, which characterizes most sociological and epidemiological research on health. Fourth, this perspective suggests that *educational attainment as conventionally measured (i.e., total years, highest grade completed, credential) may proxy time-stable (at least at the point of measurement) is driven by unmeasured cognitive and non-cognitive traits*. In theory (and with population averages (rather than individual cases)), those with more years of education or higher degree attainment have accumulated and demonstrated possession of the stock of skills necessary for promotion into that particular rank and their presence in that rank is a signal of their cumulative stock of cognitive and non-cognitive abilities. Finally and summarizing, *educational attainment should be of questionable relevance for health with appropriate controls, either direct or indirect, for typically unmeasured time-stable attributes, such as cognitive and non-cognitive abilities, that are exogenous to educational attainment and important determinants of health*. A soft version of this thesis would deem some significant portion of the educational attainment effect to be spurious with controls for cognitive and non-cognitive abilities. A harder version of the thesis would view the effects of education to be non-causal and substantively and statistically insignificant with appropriate controls for such abilities.

Given this, fruitful research would use statistical models that control for such time-stable attributes of individuals and directly or indirectly model the association between cognitive skills, non-cognitive traits, educational attainment and health. After briefly reviewing the growing literature that attempts to estimate causal effects of educational attainment on health and in doing so highlights the potential significance of unmeasured heterogeneity, such as cognitive and non-cognitive abilities, we pursue a multi-pronged strategy to untangle, skills, schooling, and health using unique longitudinal data from American adolescents followed past early-adulthood.

EMPIRICAL EVIDENCE REVISITED

Empirical efforts to rigorously interrogate the causal status of educational attainment in general or to assess the impact of skills on health fall into three realms: natural experiments of changes in levels of education at a population level, comparisons of non-twins, dizygotic, and monozygotic twins, and direct assessments of the competing influence of cognitive and non-cognitive skills on health. In the realm of natural experiments, a frequently cited study by Lleras-Muney (2005) used state variation in compulsory education laws in the United States to estimate the effect of education on mortality and concluded that education has a significant causal impact on health (see also Lillard and Malloy 2010 and Oreopoulos 2006, Silles 2009, Spasojevic 2003 for confirmatory finding in the US, the UK, and Sweden). In contrast, Mazumder's (2008) replication of Lleras-Muney's mortality findings concluded that the initial findings were not robust to different assumptions and specifications. Consistent with this, Arendt (2005), Albouy and Lequien (2009), and Clark and Royer (2010) also studied the effects of compulsory educational laws on mortality, yet found no statistically significant effects. Similarly inconsistent or ambiguous effects are found in Jurges, Kruk, and Reinhold's (2013) and Powdthavee's (2010) studies of biomarkers for health risks in the Germany and the UK.

There are similar ambiguities in the twin literature. Here, twins who are discordant on educational achievement but share the same genetic material (i.e., monozygotic twins share 100 percent, dizygotic twins share 50 percent) and family environment are used to estimate effects of education controlling for genetic endowments and shared family circumstances. Showing positive effects, Lundborg's (2008) study of twins from the US showed consistent associations between high educational attainment and both self-rated health and an index of chronic conditions. In contrast, Fujiwara and Kawachi (2009) report more mixed results with education influencing some health outcomes and not others. Similarly, recent studies of education and mortality risk among Danish twins report opposite conclusions. Here, Madsen and colleagues (2010) report that large contrasts in education produce significant differences in mortality risk, while Behrman and colleagues (2011) find no such effects.

Finally, evidence on the role of cognitive and non-cognitive traits in health dynamics is simultaneously unequivocal, complicated, and difficult to interpret. For cognitive ability, Gottfredson (2004) elaborated the idea that intelligence is the true 'fundamental cause' of health by stressing that "health self-management is inherently complex and thus puts a premium on the ability to learn, reason, and solve problems" (p. 189). Link and colleagues (2008) reviewed several studies and concluded that most show a cross-sectional or longitudinal relationship between cognitive ability and health. But further consideration of educational attainment complicates things. In some studies, socioeconomic status including educational attainment significantly attenuates the effects of cognitive ability, suggesting that educational attainment may explain the effects of cognitive ability. Other studies however show that the effects of socioeconomic status are attenuated by cognitive ability. Link and colleagues' (2008) own research was more definitive: the effects of cognitive ability were substantially reduced with controls for educational attainment and income, but the effects of educational attainment and income were substantively unchanged conditional on cognitive ability (Link et al. 2008: Table 2). Conti, Heckman, and Urzua (2010) however draw different conclusions. Analyzing longitudinal data from the 1970 British Cohort Study, they conclude that selection due to cognitive and non-cognitive skills measured in early childhood account for over half of the observed educational differences in poor health, depression, and obesity at age 30. From such research, cognitive ability is clearly implicated in health dynamics but its conditional relationship with educational attainment is much less definitive.

Evidence of the role of non-cognitive skills in health dynamics is either quite rare or routine, depending upon conceptualization. Gottfredson and Hirschi (1990) for example describe "low self-control" as characterized by impulsivity, a preference for simple tasks, riskseeking, physicality, self-centeredness, and being temperamental. From this perspective, the vast literature that relates a range of risk behaviors, including dangerous driving, substance use, involvement in crime and violence, smoking, poor diet and lack of exercise, non-compliance with medical advice, poor preventative care practices, etc to poor health could all be seen as evidence of the importance of non-cognitive traits for health over the life course (see also Moffitt et al 2011). At the same time, more direct, albeit self-reported, measures of the type that Conti and colleagues (2010) use are quite rare in socio-health research.

Summarizing across a reasonably large number of studies, evidence that educational attainment has causal effects on health is not conclusively supported (also see reviews in Eide and Showalter 2011 and Kawachi, Adler, and Dow 2010). At the same time, the evidence that links cognitive and non-cognitive skills to health dynamics is less clear and underdeveloped, but interpretation is complicated and conclusions ultimately equivocal.

THE CURRENT RESEARCH

Having articulated two theses on educational attainment and health, causal and human capital-based or spurious and educationally-endogenous, and having provided a brief accounting of relevant evidence, we now turn to the focus of our empirical research: analysis of the relationship between cognitive and non-cognitive abilities, educational attainment, and health using statistical models that have different capacities for accounting for unobserved or unmeasured heterogeneity. First, we seek to replicate the traditional finding in the literature of a strong, linear, and negative relationship between greater educational attainment and poorer health using an OLS approach and do so with consideration of direct measures of cognitive and non-cognitive abilities.[1] Second, we use random-effects regression approaches to assess the implications of unobserved heterogeneity for estimates of the effects of educational attainment and cognitive and non-cognitive abilities on health. Third, we estimate fixed-effects models that effectively control for all time-stable, unobserved abilities and further evaluate the effects of educational attainment. For all models, we also include a set of variables indexing a variety of risk behaviors and statuses for poorer health as means of a) assessing whether the effects of educational attainment are suppressed in our analyses; b) assessing the degree to which such risk behaviors and statuses statistically ‘explain’ (i.e., reduce in absolute value when included) the effects of educational attainment; and c) assessing the conditional magnitude of the educational attainment effects. Finally, for all analyses, we replicate the findings across six race-sex groups to assess the robustness of the observed effects.

DATA AND MEASURES

The data that we use in this research come from the National Longitudinal Survey of Youth – 1997 (hereafter NLSY97). The NLSY97 consists of an initial sample of 8,984 youths who were between the ages of 12 and 16 in 1997. When possible the respondents were re-interviewed annually and data were collected on a range of topics on the transition to adulthood. As of 2014, there are 15 waves of data that cover an age range of 12 to 31. In addition to non-Hispanic whites, the NLSY97 oversampled blacks and Hispanics such that there are relatively

[1] Clearly, there have been a variety of statistical approaches used to examine the relationship between education and health depending upon the metrics and nature of the outcomes. Yet as Cutler and Lleras-Muney (2008) note, the basic association is typically assessed through some elaboration of a basic regression model where $H_i = c + \beta E_i + X_i\delta + \varepsilon_I$ and H is the health status for person *i*, E is the educational attainment for person *i*, *X* is a vector of other individual characteristics (which hopefully make the coefficient for educational attainment unbiased), *c* is a sample intercept, ε is the error term.

large samples of six race-sex groups. Compared to other national surveys, panel retention is excellent with 83 percent of the sample retained through wave 15.

For a study of skills, educational attainment, and health, we capitalize on the record structure of the NLSY97 data and its position in the history of population health in America. For the former, the multi-panel record structure provides annual, repeated measures of both education and health, coupled with reasonable measures of cognitive and non-cognitive traits in adolescence, and hence allow for statistical approaches that are better at controlling for unobserved heterogeneity than traditionally used OLS approaches (see discussions in Allison 2009; Baltagi 2005; Greene 2011; Halaby 2004). In the latter case, the obesity epidemic in the United States has had profound effects on the age structure of health liabilities. As Harris (2010) notes, numerous data, including studies such as the National Longitudinal Study of Adolescent Health show unequivocally that obesity is harbinger of both short-term and longer-term chronic health problems and that a range of serious health problems (e.g., type II diabetes, hypertension) are increasingly visible through the early adult years. Given this, heterogeneity in health liabilities, including those self-perceived, is increasingly measurable in the early adult years among contemporary cohorts. Given its correspondence to the chronic disease epidemic of the contemporary era, the NLSY97 data provide unique purchase for questions of skills, education and health and an important opportunity for assessment.

Health: In these analyses, we measure health as self-rated health. This is a widely used measure that is one of the most validated survey instruments with strong and robust associations shown for a wide range of morbidities and for follow-up mortality (Chandola and Jenkinson 2000; Ferraro and Farmer 1999; Idler and Benyamini 1997; Miilunpalo et al. 1997). It has also been the basis of tens of thousands of studies including a number of highly visible sociological investigations of health in recent years (e.g., Chen, Yang, and Liu 2010; Ferraro and Farmer 1999; Lynch 2003; Moen, Dempster-McClain, and Williams, 1992; Ross and Wu 1995; Schnittker 2007; Stolzenberg 2001; Willson, Shuey, and Elder 2007). *Self-rated health* (hereafter SRH) asks respondents to describe their health on a scale from 'excellent' coded 1 through 'very good,' 'good,' 'fair,' to 'poor' coded 5. Although we recognize range limitations, we treat self-rated health as a continuous variable to ensure maximum sample representation over the 15 waves of data.[2]

Educational Attainment: A key predictor measure for this research is *educational attainment*. Although there are a number of conceptualizations, we treat attainment as a set of dummy variables indexing 'high school/GED,' 'some college,' a 'two-year degree,' or a 'four-year college degree or greater' attainment with the reference category being 'less than a high school degree.' This allows us to capture a range of meaningful contrasts in education as they relate to health and allows us to assess linearity or consider nonlinearities if apparent.

Cognitive Skills: Cognitive ability was measured in the 1997 wave of data as the percentile ranking on the *Peabody Individual Achievement Test (PIAT)* for mathematics that was administered to all students regardless of age who were in the 9th grade or lower. For purposes of comparability, we differentiate the sample into 20th percentiles to allow intuitive comparisons with categories of educational attainment.

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2 An earlier version of this paper used random- and fixed-effects logit models. The limits of such models is that they exclude all instances where there is no change in the dependent (or independent) variable, a problem that is exacerbated when the distribution is further truncated to a binary measure (e.g., fair/poor health versus good/very good/excellent health). The results however are substantively similar regardless of approach.

Non-cognitive Traits: We use three measures of non-cognitive abilities that capture different types of aptitudes and orientations. A first measure comes from the 2002 wave of data when respondents were 17 to 21 and indexes *task-orientation*. This is the degree (on a scale of one to five) that respondents were "organized" (as opposed to "disorganized"), "conscientious" (as opposed to "not conscientious"), "dependable" (as opposed to undependable), and "thorough" (as opposed to "careless"). A second measure, also from the 2002 wave, indexes *sociability* as the degree that respondents were "agreeable" (as opposed to "quarrelsome"), "difficult " (as opposed to "cooperative"), "stubborn" (as opposed to "flexible") and "trustful" (as opposed to "distrustful").[3] For both of the latter measures, we conducted a one-component principle components analysis, derived a regression-based cumulative score, and then differentiated the sample into 20th percentiles, again for easy of comparison. The last is a dummy variable that captures degree of *commitment* to schooling in 1997 and indexes respondents who were in the top 20th percentile (greater than 7 days) for unexcused absences from school in the previous year.

Behavioral Risks/States: In certain models, we incorporate a number of measures of behavioral risks and states that all have resonance in sociological research on health. A first risk measure is marital status, which has a long history in health research (Waite and Gallagher 2002), and differentiates those *married*, those *separated or divorced*, and those never married (reference category). A second set of measures captures variation in vocational activities and differentiates those *employed*, those *enrolled in school*, and those outside of the labor force and schooling. A third set of measures is based on body mass index (BMI) score calculated from self-reported

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[3] One could think of this measure as indexing an openness or orientation to social capital which in many different forums has been implicated in processes of educational attainment (e.g.,

height and weight and differentiates respondents that are *underweight* (< 18.5), *overweight* (25-29.9), *obese* (30-34.9), and *severely obese* (35 or greater). The reference category includes respondents whose BMI falls in the *optimal range* (18.5-24.9). While there are a variety of discussions over how best to measure obesity in children and adolescents, a BMI of 30 or greater is the standard indicator of obesity in adults and corresponds almost identically to the 95th percentile for respondents at ages 12 through 14 and is above the 90th percentile for ages 15 through 17 in the NLSY97 data. As discussed earlier, obesity is a particularly important health indicator for an adolescent and early adult population given its early onset and cumulative nature (Whitaker et al. 1997), its role as a primary risk factor for chronic diseases and disability (Ferraro and Kelly-Moore 2003; Hubert et al. 1983), and its connection to broader patterns of racial and socioeconomic disparities in health (Lee, Harris and Gordon-Larson 2009; Ogden et al. 2006; Paeratakul et al. 2002).

A fourth set of risk behaviors is based on the number of days smoked in the past month and the average number of cigarettes smoked per day. Based on the resulting product, respondents are differentiated in terms of those who are *casual smokers* (less than 31 cigarettes per month), *light smokers* (31 to 180 cigarettes per month), *moderate smokers* (181-600 cigarettes per month), and *heavy smokers* (more than 600 cigarettes per month). The reference category is non-smokers. While there are clearly an infinite number of ways of classifying smokers, the category chosen conforms to clear ‘cut points’ in the distribution. We also differentiate respondents with respect to alcohol consumption. Frequency of consumption was similarly derived from items indexing the number of days drinking and the average number of drinks per day. Also following ‘cut points’ in the distribution of drinking, we differentiate respondents in terms of *light drinkers* (1-30 drinks per month), *regular drinkers* (31-60 drinks per month), *moderate drinkers* (61-120 drinks per month), and *heavy drinkers* (more than 120 drinkers per month) with the reference category being abstainers (0 drinks per month).

A final risk item indexes involvement in criminal behavior. Important theoretical statements in criminology tie criminal behavior to an absence of self-control and pay particular attention to the variety of offending behaviors (Gottfredson and Hirschi 1990; Sweeten 2012). Building upon this, we differentiate respondents in terms of those that engage in no crime (reference category) and those have *low versatility* (one type), *moderate versatility* (two types), *high versatility* (three types), or *extreme versatility* (four or more types).

Controls and Stratification: Our models include a key control for *aging* captured through the panel structure of the data. This measure accounts for both well-recognized declines in health with advancing age, as well as the strong determinism of educational attainment with aging. Importantly, the latter is far from perfect given both variation in continuity of education and the multi-cohort sample. With this basic structure, our panel data cover the age ranges of 12 to 31 and less than 12 percent of the sample was still enrolled in school at the last panel. The majority of these would be classified as some college or four-year degree or greater and hence indicate right sensoring that should not bias our results (i.e., they are already of high educational attainment). We also use an indicator of race and sex to stratify the sample and assess the robustness of our findings with respect to key demographic determinants of both health dynamics and educational attainment. The measure we use distinguishes *white males*, *white females*, *Black males*, *Black females*, *Hispanic males*, and *Hispanic females*. Descriptive statistics for the full sample and the six sub-samples are shown in Table 1.

[Table 1 about here]

ANALYTIC METHODS

Ordinary Least Squares (OLS) Regression Models with Adjustment for the Clustering of Observations within Respondents: The vast majority of research on the effects of educational attainment on health use some form of a conventional regression model (Cutler and Lleras-Muney 2008). Stated more formally,

$$Y_{ij} = \alpha + \beta Ageing_{ij} + \sum_{k=1}^{K} \delta_k ED\_ATT_{ijk} + \sum_{l=1}^{L} \phi_l COG_{il} + \sum_{m=1}^{M} \gamma_m NON\_COG_{im} + \sum_{n=1}^{N} \eta_n RISKS_{ijn} + \varepsilon_{ij} \quad (1)$$

where Y_{ij} is SRH for individual *i* at time *j* and is modeled as a linear function of ageing, a *k* set of variables indexing educational attainment for person *i* at time *j*, an *l* set of variables indexing percentiles of cognitive ability, an *m* set of variables indexing non-cognitive traits, a *n* set of variables indexing different risk behaviors and states and an idiosyncratic error term, ε_{ij}. The only significant modification of this model to the traditional OLS model is an adjustment to the standard errors to account for the clustering of outcomes and predictors within individuals (Rogers 1993).

Random Effects Model: A first alternative specification is a maximum likelihood, random effects (ML-RE) model. Formally stated,

$$Y_{ij} = \alpha + \beta Ageing_{ij} + \sum_{k=1}^{K} \delta_k ED\_ATT_{ijk} + \sum_{l=1}^{L} \phi_l COG_{ijl} + \sum_{m=1}^{M} \gamma_m NON\_COG_{ijm} + \sum_{n=1}^{N} \eta_n RISKS_{ijn} + \zeta_j + \varepsilon_{ij}$$

where the model components are the same as in the earlier equation, but where there is a random intercept, ζ_j, that is independent across subjects and a residual, ε_{ij}, that is independent across subjects and time periods. Both are normally distributed with zero means and are independent of one another. For our purposes, a random-effects approach provides a more stringent control for unmeasured heterogeneity, yet can still accommodate time-stable and time-varying variables. Thus, it can provide an initial lens into the joint role of skills, schooling, and other behavioral risk and states in the production of health dynamics over time, while also mitigating some of the bias typical of OLS approaches. To account for the possibility of serial correlation, we estimate the ML-RE models with an autoregressive component with a lag of 1 (AR1).

Fixed Effects Model: The third specification is a maximum likelihood, fixed effects (ML-FE) model. With this specification, there is a parameter, α_i, which is a unique intercept for each respondent. Given this, we model deviations off of a person-specific intercept and hence control for the entire set of time-stable unobserved heterogeneity, including unmeasured cognitive and non-cognitive traits. More formally,

$$Y_{ij} = \alpha_i + \beta Ageing_{ij} + \sum_{k=1}^{K} \delta_k ED\_ATT_{ijk} + \sum_{n=1}^{N} \eta_n RISKS_{ijn} + \varepsilon_{ij}$$

This model is again as defined earlier, yet includes a person specific intercept, α for each individual *i*. In contrast to the conventional OLS (and to a lesser extent ML-RE approaches), statistical wisdom views a fixed effects approach as providing much more stringent control for unobserved heterogeneity bias, at least under most circumstances (see general discussions in Allison 2009; Baltagi 2005; Greene 2011; Halaby 2004).[4] The disadvantage of course is that they require time-varying covariates and hence cannot include measures of adolescent based skills and traits that are fixed attributes. Such models do however capture the broad, but

[4] The issue here is that one could imagine situations where time-invariant factors matter very little and hence controls for persistent heterogeneity would mitigate bias on measured variables. At the same time, one could imagine situations where time-varying factors matter very much and hence issues of model specification would be much more important. Donahue and Wolfers (2006) discuss many such examines in an analysis of recent work on the deterrent effects of the death penalty.

undefined, “stock” of time-invariant attributes of which cognitive and non-cognitive traits established in the early life course would be a key component. To our knowledge, such models have not been applied to the study of educational attainment and health. Yet, through more rigorous statistical controls, they provide a more powerful assessment of the causal impact of education attainment on health and provide a lens into the importance of time stable attributes that are formed early in life, prior to the key cut-points of educational attainment, as confounders in the education-health relationship. As with the random-effects specification, we estimate the ML-FE models with an autoregressive component with a lag of 1 (AR1).

[Figure 1 about here]

RESULTS

Our investigation begins by considering change in both the focal independent and dependent variables. This is a fundamental precondition for the random- and fixed-effects estimation that we will subsequently undertake. Clearly, the period between the mid teen and late 20s see significant change in educational attainment. In the NLSY97 data, almost all (99%) of the respondents have less than high school attainment and 97.5% are enrolled in school during the mid teen period. Over the subsequent 15 years, there is both a strong shift in the highest level of attainment and increased variance in the distribution of attainment. By wave 15, the period of the late 20s and early 30s, just under 10 percent have less than a high school degree, 26 percent have a high school or equivalency degree, 33 percent have some college, just over 6 percent have a two-year degree, and 25 percent have a four-year degree or greater. Just over 12 percent report that they are still enrolled in any schooling, but this is overwhelmingly people in the “some college” (69.5%) or four year degree or greater (26.6%) categories.

We assess change in both educational attainment and SRH more formally by estimating latent growth curve models of change over time that allow for variation in both intercept and slope. Average levels of change are shown in Figure 1. Not surprisingly, educational attainment and increasingly poorer health both increase with aging. In terms of the relevant growth parameters, a random-coefficient model for (a five-category measure of) educational attainment shows both strong growth over time (b = .145, z = 123.88) and significant heterogeneity across sample members in both the effect of aging ($\sqrt{\psi_{11}}$ = .098, z = 113.95) and the intercept (($\sqrt{\psi_{22}}$ = .475, z = 79.30). Similar trajectory of growth is seen with respect to poorer SRH. Here, the likelihood of poorer health increases with aging (b = .028, z = 36.43) and there is significant heterogeneity in both slope ($\sqrt{\psi_{11}}$ = .041, z = 58.43) and intercept (($\sqrt{\psi_{22}}$ = .579, z = 94.90). Consistent with this, rates of change for both educational attainment and health are also statistically significant for all six race-sex subgroups.

Cognitive and Non-Cognitive Traits, Educational Attainment, and Self-rated Health

Table 2 presents coefficients from OLS and ML-RE models where self-rated health is regressed on educational attainment, time-invariant cognitive and non-cognitive traits, and key time-varying risk factors. Given how cognitive ability was measured in the NLSY97, these analyses are restricted to the sample who were in 9th grade in 1997. Analysis of the full sample of respondents is pursued subsequently.

We begin by replicating the standard finding in the field of a strong, linear association between educational attainment and SRH using an OLS approach. In model 1, coefficients for educational attainment increase from -.021 (*ns*) for those graduated from high school, to .206 (p < .01) for those with some college, to -.285 (p < .01) for those with a two-year college degree, to

-.522 ($p < .01$) for those with a four-year college degree or greater. Importantly, the latter two coefficients indicate strong associations with SRH, 30% and 56% of a standard deviation, respectively. In summary, the overall pattern of linear effects that become very large with high levels of educational attainment is strongly consistent with a wide range of estimates seen in prior work, regardless of differences in sample, differences in health outcomes, and differences in ways of measuring educational attainment.

Model 2 shows coefficients for categorical measures of cognitive and non-cognitive traits. There are two significant conclusions. First, such traits do matter for health dynamics with statistically significant and reasonably linear increases in SRH with movement up percentile ranks. Still, the magnitude of the effects is decidedly smaller than those seen for educational attainment. For example, while the effect of attaining a four-year degree or greater is -.522, the coefficients for being in the top 20^{th} ability percentiles are -.225 (cognitive), -.209 (task oriented), -.233 (sociable), and .186 (commitment). In general, the latter are less than half the size of the four-year degree effect and more similar in magnitude to the two-year degree effect. While this is confirmed in model three where educational and cognitive and non-cognitive traits are included, there is an important qualification in that the educational attainment effects are reduced in size when the cognitive and non-cognitive trait measures, measures that are easily viewed as exogenous, are included. Here, the effect of having some college attainment is reduced by 42 percent [(-.206 - -.119) / -.206], the effect of having a two-year degree is reduced by 38 percent [(-.285 - -.176) / -.285], and the effect of having a four-year college degree or greater is reduced by 31 percent [(-.522 - -.361) / -.522]. Still, all three educational attainment coefficients remain statistically significant and the effects for higher levels of attainment indicate moderate conditional associations with SRH that are considerably larger, typically twice the size, than those of cognitive and non-cognitive traits.

There are further reductions in the magnitude of the educational attainment effects when the set of time-varying, proximal determinants of health are included (see model 4). While still statistically significant, the effect of having some college is reduced by a further 45 percent (b = -.066, p < .01), the effect of having a two-year degree is reduced by a further 16 percent (b = -.148, p < .01) and the effect of having a four-year degree or more is reduced by a further 29 percent (b = -.258, p < .01). Still, the OLS models suggest comparatively large effects for educational attainment, particularly for a four-year college degree or greater in comparison to both those of cognitive and non-cognitive abilities and in comparison to the risk behavior and state variables. Here, the corresponding coefficient, conditional on cognitive and non-cognitive traits and the risk behavior and state set, is as large as any of the other coefficients in the model with the exceptions of obesity and severe obesity and moderate and heavy smoking. One conclusion is that the educational effects are very consistent with results from most prior work where educational attainment has substantive associations with health that are moderate to large in magnitude, effectively linear, and robust to the inclusion of key proximal determinants of health. A second conclusion is that measures of cognitive and non-cognitive abilities have substantive associations with SRH and substantially reduce the effects of educational attainment.

We have argued that problems of unmeasured heterogeneity likely distort the magnitudes of the educational attainment effects and we explore this next by re-estimating the models using a maximum-likelihood, random-effects specification. In general, the results indicate substantial bias in the OLS coefficients. Coefficients in model 5 include only educational attainment and aging and the magnitude of the former are substantially lower than that seen using an OLS approach. For example, while the OLS coefficient for some college attainment is -.206, the ML-

RE coefficient is -.040 ($p < .01$), a reduction of 79 percent. Similarly, the coefficient for a two-year degree is reduced by 70 percent (-.285 versus -.085), while the coefficient for a four-year college degree or more is reduced by 66 percent (-.522 versus -.179). While all are still statistically significant with the ML-RE specification, none of the effects would be considered large and the even the effect of a four-year or more college degree, the highest level of attainment we consider, would be deemed small by conventional standards.

Model 6 shows coefficients for the set of time-invariant cognitive and non-cognitive abilities and the effects are much more resilient with the ML-RE specification than is the case with educational attainment. While the coefficients for educational attainment were reduced by two-thirds or greater, the coefficients for the various levels of cognitive and non-cognitive ability are essentially unchanged from those estimated with an OLS approach (see model 2). Equally important, when educational attainment is added (see model 7), the latters effects are reduced even further. Here, only a four-year college degree or greater has a statistically significant effect ($b = -.132$, $p < .01$) and even so the effect is quite small, approximately 1/7th of a standard deviation in SRH. The effects for other post-secondary attainment are estimated as quite close to zero ($<= \pm$ .05). In contrast, the effects for cognitive and non-cognitive abilities are essentially unchanged with the consequence that they typically have effects that are somewhat larger than those of high educational attainment. For example, while the largest effect for high educational attainment is -.132, the effects for being in the highest 20th percentile of cognitive ability is -.194. Similarly, the effects for the highest levels of of task-orientedness, sociability, and commitment are -.200, -.229, and .184, respectively. Interestingly, the effect for the highest level of educational attainment is similar in magnitude to being in the 40th to 60th percentile of task-orientedness and sociability (and, although not shown, commitment). In general, the effect sizes for high levels of cognitive and non-cognitive traits tend towards the moderate range and this is quite impressive given their distal quality and that the model controls, to a good extent, for unmeasured heterogeneity *and* includes the endogenous measures of educational attainment. As a final issue, the inclusion of the time-varying risk behavior does not dramatically alter the story (see model 8). While, both the educational attainment effects and the cognitive and non-cognitive trait effects are somewhat reduced in magnitude, the latter have residual effect sizes that are larger. For the effect sizes for being in the highest percentiles of cognitive ability, task-orientedness, and sociability are substantially larger than those of most of the risk behavior and states measures and really only smaller than that of being obese or severely obese. In contrast, the effect size for a four-year college degree or greater is similar in magnitude to those of regular smoking, using other drugs, and extensive and versatile criminal activity, but substantially smaller than those of moderate or heavy smoking or being overweight, obese or severely obese.

Table 3 reports the replication results for the ML-RE models for the six race-sex subgroups. Our purpose here is simply to assess the robustness of the results for each of the subgroups with the idea being that generalizability across groups would strengthen claims about the significance of skills and/or educational attainment for health dynamics. Odd numbered models are replications of model 7 from Table 2, while the even numbered models are replications of model 8, the model that includes the set of time-varying risk behavior and state variables. Beginning with educational attainment, evidence of linearity in effects and large effect sizes with increasing educational attainment is not strong. Only white and Hispanic females show a clear pattern of linearity. Evidence of the significance of a four-year college degree or more is stronger, but still far from robust. Of the 12 coefficients estimated, seven are statistically significant and, of the seven, only one has a magnitude in the moderate range (b = -

.234, $p < .01$, Hispanic males). Evidence of generic college gains with respect to health has even weaker support. For the (odd numbered) models without time-varying risk behavior and state measures, only 3 of 12 coefficients for some college or a two-year degree are statistically significant and the largest effect size is -.118 (white females). For the (even numbered) models with time-varying risk behavior and state measures, only 1 of 12 coefficients is statistically significant and its effect size is small ($b = -.09$, $p < .05$, Hispanic males).

For cognitive and non-cognitive abilities, evidence of substantive associations is stronger. Being in the top 20th percentile for cognitive ability has statistically significant associations with SRH for 8 of 12 models and effects sizes are often moderate in magnitude (> .2) and larger than those seen for four-year or more degree attainment. For example, being in the top 20th percentile for cognitive ability for white males has an association with SRH that is almost twice as large as that of having a four-year or more college degree (-.252 versus -.127). For white females, the association for high cognitive ability is 43 percent greater than that of having a four-year college degree (-.272 versus -.190). In general, the associations for high cognitive ability are larger than those of a four-year degree for white males and females and for Hispanic females, are similar (and small and not statistically significant) for Black males and females, and are somewhat smaller only in the case of Hispanic males (-.157 versus -.234). For task-orientedness, there are statistically significant effects for being in the top 20^{th} percentile also for 8 of 12 models and the effect sizes are similar or larger in magnitude that those of a four-year or more degree for 10 of 12 coefficients. Similarly, being in the top percentiles of sociability yield similar or larger effects to those of high educational attainment in 9 of 12 cases. Finally, high levels of commitment yield coefficients that are as large or larger than those of a four-year degree or greater. In sum, the race-sex replications reinforce the importance of cognitive and non-cognitive traits for health and the conclusion that much of the observed education effect is a function of such traits and other unmeasured time-stable attributes.

Fixed Effects Estimates of Educational Attainment and Self-rated Health

The objective of the first set of analyses was to directly examine the associations between cognitive and non-cognitive traits, educational attainment, and SRH, and to do so with models that exert better control over unobserved heterogeneity, particularly time-stable traits developed in the early life course, that could bias estimates of educational attainment. We further the inquiry by employing a second strategy designed to control even more strongly for the entire battery of time-stable, unobserved factors, of which the cognitive and non-cognitive traits as measured are a key subset, using a maximum likelihood, fixed effects approach. As the sample is somewhat different than that used in the previous analyses, we follow the same procedure as before where we first replicate the traditional finding in the field of a strong, linear education gradient in SRH using a conventional OLS approach and then examine estimates derived from a ML-FE approach. As before, we further consider the findings when the model includes a key set of time-varying risk behavior and state measures and examine robustness of conclusions across the six race-sex groups. These results are shown in tables 4 and 5.

Model 1 in table 4 includes only coefficients for time-varying educational attainment and a control for aging estimated using ordinary least squares (OLS) regression. As before, the pattern of coefficients conforms very strongly to expectations. There is a strong linearity in the association where the coefficients increase in magnitude from -.038 ($p < .01$) for having graduated high school to -.204 ($p < .01$) for having some college to -.274 ($p < .01$) for attaining a two-year college degree to -.537 ($p < .01$) for having attained a four-year degree or greater.

Equally important, the latter coefficient would be deemed large by any standard metric, corresponding to 56 percent of a standard deviation in SRH. The inclusion of the set of time-varying risk behavior and state measures (see model 2) reduces the size of the educational attainment coefficients somewhat, but the size of the coefficients remains substantial. For example, the coefficient for a four-year degree or more is -.373 ($p < .01$) which is moderate to large and is much larger than most of the time-varying risk measures, is similar in magnitude to the associations for obesity and regular or heavy smoking, and is really only substantially smaller than the effect for severe obesity ($b = .654$, $p < .01$). Again, these effects are very much in line with expectations and consistent with previous findings on education gradients in health.

The story changes quite radically when an ML-FE approach is used. Here, only the effect for a four-year degree or more is negative and statistically significant, but the magnitude of the effect is small, perhaps even trivial. Here, the coefficient for a four-year degree is -.055 ($p < .01$), which is reduced by 90 percent from that seen with an OLS specification and is only 1/17th of a standard deviation in SRH. The limited magnitude of the educational attainment effects is echoed in comparisons with the time-varying risk behavior and state measures. For example, the magnitude of its effects are 1/3rd that for obesity ($b = .164$, $p < .01$) and 1/6th that for severe obesity ($b = .308$, $p < .01$). At the same time, the effect size is somewhat smaller than the effect for casual smoking ($b = .069$, $p < .01$), less than half the size of the effect for light smoking ($b = .134$, $p < .01$), less than a third the size of the effect for regular smoking ($b = .186$, $p < .01$), and approximately 1/4 of that of heavy smoking ($b = .215$, $p < .01$). It is also somewhat smaller than the effects for using other drugs ($b = .071$, $p < .01$) and moderate ($b = .071$, $p < .01$) and extensive, versatile offending ($b = .089$, $p < .01$). At the same time, it effect size is similar in magnitude to the effect of being separated or divorced, being underweight or overweight, using marijuana, and different levels of criminal activity, but these effects are themselves quite small. The importance of unmeasured heterogeneity in biasing the educational attainment effects is further reinforced when one considers that educational attainment showed large absolute and relative magnitudes with an OLS specification and that it is only with the ML-FE approach that controls for such factors that educational attainment seems to be of questionable significance.

Estimates based on the race-sex subsamples are shown in Table 5 and underscore the full sample conclusions. To summarize a fair amount of information succinctly, the pattern of effects strongly support the full sample in showing limited effects of educational attainment on health once more stringent controls for unobserved heterogeneity, including early formed cognitive and non-cognitive abilities, are incorporated. More specifically, the OLS models show statistically significant, linear effects of increasing educational attainment that are moderate to large in size for four-year college degree or greater attainment for 11 of 12 models. Moreover, if we use the overall pattern of educational attainment effects seen in the full sample analyses as a benchmark, there are statistically significant effects of expected relative magnitudes in 41 of 48 instances. On the issue of magnitude, OLS coefficients for a four-year degree or greater in the models are substantial and range from .356 for Black males to .665 for white females when time-varying risk behavior and state measures are not included and from -.245 (Hispanic females) to -.441 (Hispanic males) when they are. In contrast to this robust pattern of association, coefficients produced using an ML-FE approach are statistically significant and negative in only *one* (a four-year degree or more for Hispanic males) of 48 instances and even here the effect size is small ($b = .142$, $p < .01$). In almost all other instances, coefficients are estimated close to zero ($\approx\pm .05$) and not statistically significant. Given this, there is obviously no evidence of linearity or any other type of variation in effect size with different levels of educational attainment. In sum, the

ML-FE provide little to no evidence of a substantial relationship between educational attainment and SRH, let alone one that is large in size, linear in form, or statistically significant, once controls for time-stable, unmeasured attributes are incorporated.

DISCUSSION AND CONCLUSION

Our objective in this research has been to challenge conventional wisdom of a human capital account and derivative causal interpretation of the positive association between educational attainment and health. We do so by articulating an alternative understanding of the dynamics of educational attainment that highlights the importance of cognitive and non-cognitive abilities that are formed early in the life course as the fundamental and necessary drivers of educational attainment. Importantly, such attributes are developed much earlier than the typical demarcation points of educational gradients that characterize contemporary research on education and health and have important theoretical connections to the social and psychological dynamics that shape trajectories of health over the life course.

Our empirical analyses provide evidence against the widely held interpretation and considerable evidence of the importance of cognitive and non-cognitive abilities, measured and unmeasured, time-stable and time-varying, for health dynamics. To recap, we have five key findings. First, traditional OLS approaches show a strong, linear relationship between educational attainment and SRH where high levels of educational attainment have effect sizes that rival or best some of the strongest proximal determinants of health. These findings are robust across six race-sex groups. Second, measured cognitive and non-cognitive ability account for a sizable proportion of the effects of educational attainment on SRH and are easily viewed as exogenous and sources of spuriousness that are seldom measured in education-health research.

Third, the application of appropriate controls for unmeasured heterogeneity further reduce the magnitude and statistical significance of the educational attainment effects, but have much less of an impact upon the effects of cognitive and non-cognitive abilities. The latter have effects that are little changed from that seen with an OLS specification and support the conclusion that such abilities are an important, yet independent, aspect of unmeasured, time-stable traits that are consequential for health. These findings too are robust across six race-sex groups. Fourth and derivative of the prior conclusions, the effects of high levels of cognitive and non-cognitive abilities are consistently larger than those of educational attainment, including the effects of a four-year college degree or greater, when we include appropriate controls for unmeasured time-stable traits formed early in life. Finally, and particularly important, the effects of educational attainment, including that of a four-year college degree or greater, are either reduced to a level where they are small or very small in magnitude, are typically not statistically significant, and where one could legitimately question their overall importance for health dynamics when we employed a fixed-effects approach that effectively controls for the entire bundle of time-stable traits that predate and are exogenous to educational attainment. Reinforcing this point is a comparison with a broad set of risk behaviors and states where the latter have effects that are often several magnitudes greater than that of high educational attainment. These findings are also robust across six race-sex groups. Taken together, the findings cast considerable doubt on the typical causal interpretation of educational attainment and health, highlight the importance of cognitive and non-cognitive skills that are formed in early part of the life course, and in doing so raise questions about the typical human capital interpretation of the education-health relationship (e.g., Mirowsky and Ross 2003; Ross and Wu 1995).

Our research will certainly not be the final word on whether the typically observed association between educational attainment and health is indeed causal and the complicating role of cognitive and non-cognitive abilities. Still, the tests that we employ are appropriate and important in that they use longitudinal data and dynamic models that better account for persistent, unobserved heterogeneity that is a potential source of spuriousness in the association of education and health. Moreover, given that we offer a plausible alternative theory of educational attainment, one that highlights cognitive and non-cognitive abilities that develop early in life and the derivative idea that educational attainment is life course contingent and substantially 'endogenous,' our core findings that the conventionally observed relationship does not hold up when statistical approaches directly incorporate measures of cognitive and non-cognitive abilities and account for unmeasured heterogeneity is strong evidence against the typical interpretation. This evidence is made even stronger by the fact that we have no difficulty replicating the traditional finding in the field of a strong, linear, and robust association between educational attainment and health using conventional OLS approaches and the NLSY97 data. Yet as educational attainment does not have the same effects on health after controlling for observed and unobserved time-stable attributes of individuals, this suggests that the effect found in conventional analyses may reflect such traits, of which cognitive and non-cognitive abilities are an important subset that have not been accounted for in prior research.

Empirically, our work builds upon and extends a growing body of work, most of it outside of sociology, which questions the causal interpretation of education on health. While natural experiments and studies of twins are clearly valuable, they have well recognized limitations in that statistical power is often low, scope conditions are often vague (e.g., to what populations do natural experiments that occur in a given place at a given time and typically apply only to select cohorts apply), and modes of instrumentation are often laden with heavy and sometimes questionable assumptions (e.g., that results from twin studies generalize to the wider population or even that twins who are discordant on some factor generalize to the larger population of twins (Madsen and Osler 2009)). In contrast, our analyses of the NLSY97 data generally show null effects of educational attainment and enrollment that are robust for both a nationally representative sample of Americans and among six race-sex subsamples. From the standpoint of conventional statistics, well-powered OLS and fixed-effects analyses and the breadth and heterogeneity of the samples make the evidence against a human capital and causal interpretation compelling.

From a theoretical standpoint, we emphasize the role of cognitive and non-cognitive abilities in that these can clearly be understood as the engines of educational attainment and serve to connect other factors such as early family circumstances, community context and even early health profiles to educational attainment (Haas 2006; Palloni 2006). In doing so, we emphasize the dynamics of early skill formation, perhaps prior to school entry or during the earliest years and their role in educational attainment deep into the life course (Entwisle and Alexander 1989). In doing so, the findings challenge the traditional human capital model that is the hegemonic interpretive framework within research on education and health. Still, there may be other interpretations of our findings, including those that highlight the roles of genetic endowments, family structure, family processes, social class, neighborhood context, to name but a few. All certainly satisfy the temporal criteria in that they appear early in life, are relatively time-stable either by timing or measurement, and are implicated in both educational and health dynamics. Yet, one could argue that the reason *why* such factors matter for educational attainment and health is because they influence the development of cognitive and non-cognitive skills and thus are part of the foreground that produces such skills (see various discussions in Cunha et al. 2006; Entwisle and Alexander 1993; Farkas 2003; Heckman 2006; Lareau 2000). Given that the evidence points most clearly to factors that emerge and solidify in the early life yet is still ambiguous on the scope and dimensionality of skills that matter for education and health and unclear on the early life dynamics and investments that shape them, our research should serve as a motivation for future research that further examines such issues in different ways.

One important question that has received surprisingly little attention in the literature is exactly how complex general or routine health management actually is. In her discussion of intelligence and health, Gottfredson (2004: 74) argues that "health self management is inherently complex." We are unclear that this is the case and suspect that degree of complexity increases with extent of illness and extent of treatment. This however complicates conceptualization in that one is already compromised with respect to health when one specifies the conditions that are seen to produce better or worse health (e.g., comprehension and compliance with physician recommendations). A counter argument would be that health self management is not particularly complicated over the vast majority of the life course and not particularly complicated for the majority of the population that spends most of its time free of complex diseases. Certainly, the basics of diet, physical activity, and the avoidance of risk behaviors and situations that would limit exposure to accidents and a range of chronic diseases does not seem to require high levels of cognitive ability and would be mitigated substantially by even moderate levels of self-control. If the latter is true, then basic cognitive and non-cognitive skills acquired in childhood may be more than sufficient for maintenance of health and high levels of educational attainment, while important for a range of social and psychological outcomes, may have little added benefit.

One possible criticism for our work is that the sample is too young, ages 12 to 31, to adequately assess the relationship between education and health. While it is clear that there is a large literature showing an education gradient in health in later life and educational differences in mortality risk (see earlier discussion), four features of our research speak against this argument as a general point of critique. First, the NLSY97 data clearly show the conventional finding of large education gradients in SRH and it is only with a more stringent set of statistical controls that the effects dissipate. Second, there is considerable evidence that educational gradients in health emerge relatively early in life and that such differences may be particularly evident among more recent cohorts given the rising prevalence of obesity and its consequent impact upon cardiovascular risks, type II diabetes, joint and muscle problems, and other weight related vulnerabilities that extend into later life (see discussion in Harris 2010). Indeed, the highly influential work of Geronimus (1992; 2005) highlights the onset and development of race-sex differences in health in late adolescence and the transition to adulthood. Third, our research clearly shows effects of behavioral risk, obesity and smoking for example, whose role in health dynamics is not restricted to either younger or older people. The fact that both factors have robust effects that parallel those of high educational attainment in conventional OLS models but then literally swamp the latter's effects with better controls for unmeasured heterogeneity highlights the issue of the endogeneity of educational attainment with respect to unmeasured attributes. Finally, the core pattern of an observed education gradient that is diminished with the inclusion of measured cognitive and non-cognitive abilities, that is further diminished with additional controls for unmeasured, time-stable heterogeneity, and that then virtually disappears with a fixed-effects specification is generally robust across race-sex subsamples. In establishing this pattern, we are particularly careful to assess such things with attention to statistical significance, effect size, and functional form. In the end, the strength of our evidence lies in the fact that the NLSY97 data *do show* the expected association when one uses the same types of statistical techniques used in prior research, yet *do not show* the expected association when there are more explicit controls for unobserved heterogeneity bias and direct measures of cognitive and non-cognitive abilities.

The findings from conventional analyses are however valuable in their own right. Those with lower educational attainment have a greater likelihood of health problems and early mortality. Population science and public policy is not dependent upon causality. Even if the real causes of poorer health are not observed, we can still make statistical and substantive predictions about who is most likely to suffer health deficits over the life course. As such, educational attainment, a variable easily and typically measured in a wide range of health data, still provides a lens into social disparities in health regardless of its causal status. Indeed, the recent work on temporal dynamics of educational attainment and mortality risk says some very important things about the changing nature of stratification and health in the contemporary era (e.g., Montez et al. 2011). At the same time, it is unlikely, given our findings, that manipulations to education, either at an individual level or at system level, will yield significant improvements in population health (cf. Galea et al 2011; Lleras-Muney 2005; Schoeni et al. 2008). As such, education policies that simply seek to enhance educational attainment without attention to early skill formation will likely be quite limited as health policy. Moreover, questionable causal links between education and health may be an important part of explanations for the apparent paradox of the epidemic of chronic disease in the United States and other countries that is occurring alongside the greatest level of formal education these populations have ever seen.

In the end, it is unlikely that education will cease being a central variable in sociological research on health. Still, this research has challenged its causal status and theoretical interpretation and now joins an growing body of work that points to typically unmeasured cognitive and behavioral aspects of individuals (and families and contexts), particularly those of early life, and what these may mean for health dynamics over the life course. At minimum, we need to consider the possibility that our current etiological frameworks that link education to health may be wrong, we need to consider what dimensions of health may or may not have causal relations with educational attainment, and design research that identifies and measures other, potentially new factors that may link social position to health over the life course. A better understanding of the social and psychological dynamics that yield massive health disparities and diminished life expectancies might do well to focus on the nexus of early family context and the development of self-reproducing cognitive and non-cognitive abilities that are increasingly viewed as powerful engines of educational attainment and are likely implicated in heterogeneity in health over the life course.

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Appendix A. Cognitive and non-cognitive ability and educational attainment.

As the inclusion of cognitive and non-cognitive abilities are not particularly commonplace in educational research in sociology, we provide a brief illustration of their importance using data from the cohort of 12 year olds in 1997 in the NLSY – 97. Here we estimate two sets of models, an OLS model predicting total years of education by age 27 and a multinomial logit model predicting different types of educational attainment by the same age. Although results are not dependent upon the choice of cohort, we focus on the 12 year olds in order to identify cognitive and non-cognitive abilities at the earliest opportunity, in this case cognitive ability prior to the teenage years and non-cognitive abilities prior to the modal age of completion of high school (17-18 years of age). Importantly, these also predate the typical first point of demarcation for education gradients in health.

The models include two sets of predictor variables. The first is a set of dummy variables indexing race and sex and we use these a) to establish a benchmark of effect sizes given that these capture a range of social advantages and disadvantages associated with communities, economic circumstances, family structure and process; and b) to assess the degree to which cognitive and non-cognitive ability established in early life can account for such differences. The second set of variables is the indicators of cognitive and non-cognitive ability that we use to assess health dynamics and the association between educational attainment and health. These include cognitive ability, task-orientedness, socialability, and commitment. Results are shown in appendix table A.

Beginning with models predicting total years of schooling, a first model shows large differences across race and sex groups with white females having the highest level of attainment ($b = .603$, $p < .01$) and Black ($b = -1.073$, $p < .01$and Hispanic males ($b = -1.050$, $p < .01$having substantially lower attainment (see model 1). By conventional standards, these effects are quite large, accounting for one-quarter of a standard deviation in the case of white females and just under a half a standard deviation in the cases of Black and Hispanic males. Model 2 includes dummy variables indexing different percentiles of cognitive and non-cognitive abilities. In the former case, the effects are strongly linear and the two higher percentiles show extremely large effects on total years of schooling. In the case of the 60th to 80th percentile, the effect is over half a standard deviation in years of schooling (b = 1.460, p < .01). In the case of being above the 80th percentile, the effect is just under a standard deviation (b = 2.262, p < .01). Even being in the 40th percentile for cognitive ability has effects that are similar in magnitude to the cumulative disadvantage associated with being a Black or Hispanic male. For task orientation, the effects are again substantively linear with the highest percentile showing a fairly large effect, just under a third of a standard deviation (b = .677, p < .01). Commitment shows an even larger effect (-.808, p < .01). Effects are less linear with respect to sociability, but even here there is evidence of substantively large effects (e.g., b = .706, p < .01 for the 60th percentile). As a final issue, the inclusion of cognitive and non-cognitive abilities that are endogenous, almost regardless of the theoretical model that one could logically pose, statistically explain seventy-five to eighty percent of the effects of differentials in years of schooling for Black and Hispanic males and actually turn the null coefficient for Black females positive.

Models 3 through 13 elaborate these points by examining effects on different levels of educational attainment, differentiating those without a high school degree from those a) with a high school degree, b) those with some college, c) those with a two year college degree, d) those with a four-year college degree, and e) those with some graduate school experience or degree. To summarize a considerable amount of information, we highlight four features of the data. First, race-sex differences in educational attainment become more pronounced with advanced degrees. For example, there are no significant differences with respect to high school degree attainment but there are significant and substantively large differences for four-year degree attainment for four of five contrasts and the fifth contrast is large in magnitude and in the expected theoretical direction (i.e., disadvantage for Hispanic females).

Second, the inclusion of measured cognitive and non-cognitive abilities account for race-sex differences in a large number of instances, with the consistent exception of the advantages seen for white females. Extent of statistical explanation is clearly variable, but is typically greater than fifty percent and in many instances is one hundred percent (e.g., four-year degree attainment among Black females). Third, the effects of cognitive ability strongly increase in magnitude with more advanced degrees. For example, being above the 80th percentile for cognitive ability increases from .592 (*ns*) for high school graduation to 2.134 (p < .01) for some college to 2.290 (p < .01) to 3.709 (p < .01) for a four-year college degree or greater. Equally interesting, the effect of being simply above the 40th percentile for cognitive ability is larger than even the largest race-sex disadvantage regardless of the attainment contrast considered. Fourth, the effects for non-cognitive abilities, while somewhat smaller in magnitude, show the same basic pattern of effects. For the highest level of task-orientedness, effect sizes increase from .419 (*ns*) for high school graduation to 1.203 (p < .01) for a four-year degree or greater. For sociability, effect sizes increase from .744 (*ns*) to 1.517 (p < .01). Effects of commitment increase linearly from -.047 (*ns*) to -1.361 (p < .01).

To summarize, analyses of cognitive and non-cognitive abilities and educational attainment show substantively large effects that buttress our argument that such abilities are fundamental precursors to processes of educational attainment. Translating coefficients into odds-ratios reinforces this point. Being in the highest percentile category for cognitive ability increases the likelihood of a four-year college degree by over *40 times*, being in the highest percentile category for being task oriented increases likelihood by*3.3 times*, being in the highest percentile category for sociability increases likelihood by *4.6 times* and having a particularly low level of commitment decreases likelihood by *75 percent*. Considering them as joint effects, the evidence is strong that cognitive and non-cognitive abilities formed early in life are fundamental predictors of education attainment and may explain important, frequently referenced, sociodemographic differences in educational attainment.

Figure 1. Temporal Trends in Health and Educational Attainment
NLSY97, 1997-2014

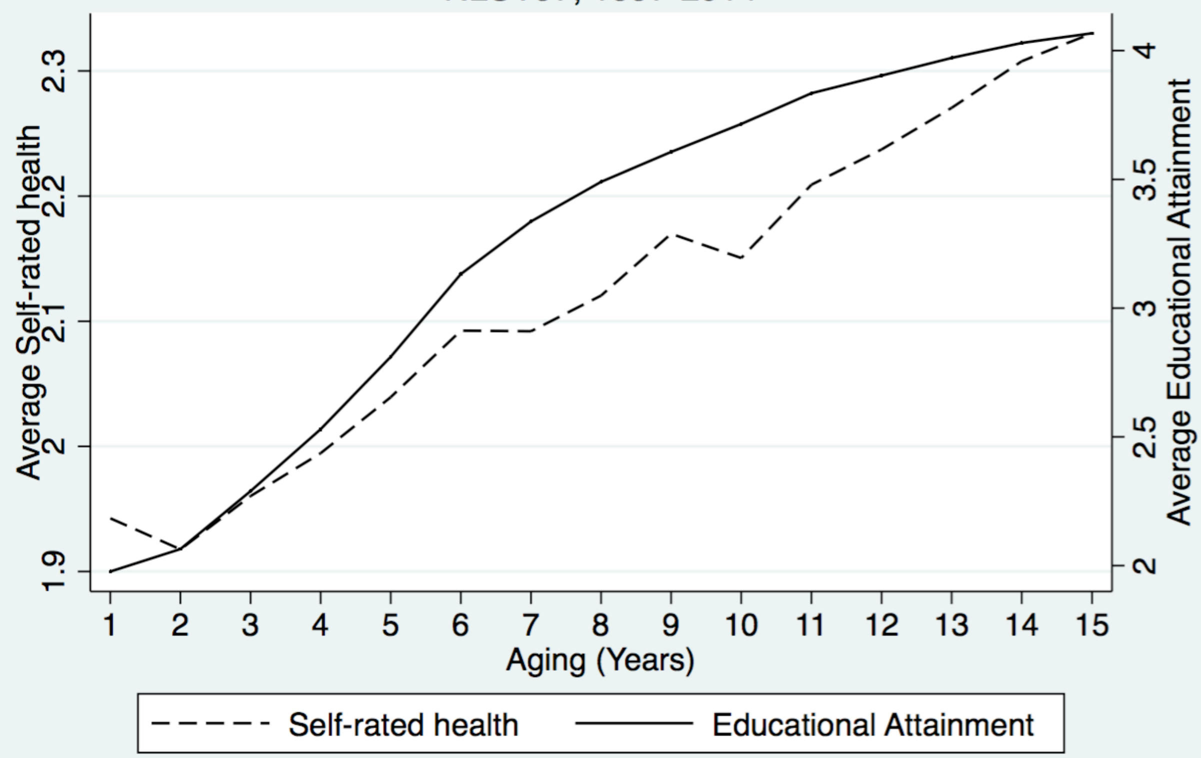

Table 1. Descriptive statistics, NLSY97.

	Mean	SD	Minimum	Maximum	N
Self-rated health	2.116	.951	1	5	116906
Aging (years)	8	4.321	1	15	134760
Educational attainment					
High school/GED	.220	.414	0	1	116662
Some college	.304	.460	0	1	116662
Two-year degree	.024	.152	0	1	116662
Four-year degree or more	.102	.303	0	1	116662
Cognitive ability	2.854	1.640	1	5	90660
Non-cognitive traits					
Task orientedness	3.041	1.419	1	5	72810
Sociability	3.038	1.431	1	5	73050
Truant	.209	.406	0	1	130305
Marital status					
Married	.151	.358	0	1	116827
Separated/Divorced	.027	.163	0	1	116827
Main activities					
Employed	.719	.449	0	1	116431
Enrolled in school	.419	.493	0	1	116662
Body mass index					
Under-weight	.052	.223	0	1	112014
Over-weight	.260	.438	0	1	112014
Obese	.111	.314	0	1	112014
Severly obese	.077	.267	0	1	112014
Drinking					
Light	.104	.305	0	1	115279
Regular	.047	.211	0	1	115279
Moderate	.053	.224	0	1	115279
Heavy	.066	.249	0	1	115279
Smoking					
Casual	.089	.284	0	1	115656
Light	.086	.280	0	1	115656
Moderate	.127	.333	0	1	115656
Heavy	.018	.132	0	1	115656
Drug use					
Marijuana	.206	.404	0	1	115787
Other drugs	.047	.212	0	1	116067
Criminal Activity	.281	.739	0	4	115811

Table 2. **OLS and Random-effect coefficients: Self-rated health regressed on educational attainment, cognitive ability, select non-cognitive traits, and other time-varying determinants, NLSY97.**

	OLS	OLS	OLS	OLS	ML-RE(AR1)	ML-RE(AR1)	ML-RE(AR1)	ML-RE(AR1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aging	0.048***	0.028***	0.041***	0.032***	0.032***	0.027***	0.030***	0.028***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Educational attainment								
High school graduate	-0.021	.---	-0.001	-0.037***	0.031**	.---	0.033**	-0.003
	(0.014)		(0.013)	(0.014)	(0.014)		(0.014)	(0.015)
Some college	-0.206***	.---	-0.119***	-0.066***	-0.040***	.---	-0.014	-0.013
	(0.012)		(0.012)	(0.012)	(0.013)		(0.013)	(0.013)
Two-year degree	-0.285***	.---	-0.176***	-0.148***	-0.085***	.---	-0.053	-0.070**
	(0.030)		(0.029)	(0.029)	(0.031)		(0.031)	(0.032)
Four-year degree or more	-0.522***	.---	-0.361***	-0.258***	-0.179***	.---	-0.132***	-0.130***
	(0.017)		(0.018)	(0.018)	(0.020)		(0.020)	(0.021)
Cognitive ability								
20th Percentile	.---	-0.052***	-0.033**	-0.032**	.---	-0.054	-0.049	-0.043
		(0.013)	(0.013)	(0.013)		(0.029)	(0.029)	(0.027)
40th Percentile	.---	-0.026*	-0.002	-0.007	.---	-0.032	-0.024	-0.024
		(0.014)	(0.014)	(0.014)		(0.033)	(0.032)	(0.031)
60th Percentile	.---	-0.101***	-0.065***	-0.068***	.---	-0.099***	-0.088***	-0.085***
		(0.013)	(0.013)	(0.012)		(0.029)	(0.029)	(0.028)
80th Percentile	.---	-0.225***	-0.152***	-0.141***	.---	-0.221***	-0.194***	-0.174***
		(0.010)	(0.011)	(0.011)		(0.024)	(0.024)	(0.023)
Task orientedness								
20th Percentile	.---	-0.048***	-0.042***	-0.037***	.---	-0.051	-0.049	-0.045
		(0.013)	(0.013)	(0.013)		(0.030)	(0.029)	(0.028)
40th Percentile	.---	-0.103***	-0.093***	-0.079***	.---	-0.104***	-0.101***	-0.088***
		(0.013)	(0.013)	(0.013)		(0.030)	(0.030)	(0.029)
60th Percentile	.---	-0.131***	-0.114***	-0.091***	.---	-0.130***	-0.124***	-0.103***
		(0.013)	(0.013)	(0.012)		(0.030)	(0.029)	(0.028)
80th Percentile	.---	-0.209***	-0.189***	-0.141***	.---	-0.208***	-0.200***	-0.153***
		(0.013)	(0.013)	(0.013)		(0.031)	(0.030)	(0.029)
Sociability								
20th Percentile	.---	-0.096***	-0.092***	-0.078***	.---	-0.103***	-0.102***	-0.085***
		(0.013)	(0.013)	(0.013)		(0.029)	(0.029)	(0.028)
40th Percentile	.---	-0.139***	-0.130***	-0.109***	.---	-0.145***	-0.141***	-0.118***
		(0.013)	(0.013)	(0.013)		(0.030)	(0.030)	(0.029)
60th Percentile	.---	-0.169***	-0.159***	-0.133***	.---	-0.172***	-0.169***	-0.142***
		(0.013)	(0.013)	(0.013)		(0.030)	(0.030)	(0.028)
80th Percentile	.---	-0.233***	-0.221***	-0.196***	.---	-0.233***	-0.229***	-0.202***
		(0.013)	(0.013)	(0.013)		(0.030)	(0.030)	(0.029)
Committment	.---	0.186***	0.169***	0.117***	.---	0.190***	0.184***	0.135***
		(0.011)	(0.011)	(0.011)		(0.024)	(0.024)	(0.023)
Marital Status								
Married	.---	.---	.---	-0.009	.---	.---	.---	-0.002
				(0.012)				(0.014)
Divorced/Separated	.---	.---	.---	0.039	.---	.---	.---	-0.032
				(0.030)				(0.030)
Main Activities								
Employed	.---	.---	.---	-0.069***	.---	.---	.---	-0.020**
				(0.009)				(0.008)
Enrolled in school	.---	.---	.---	-0.087***	.---	.---	.---	-0.041***
				(0.011)				(0.011)
Body Mass Index								
Underweight	.---	.---	.---	-0.072***	.---	.---	.---	-0.071***
				(0.009)				(0.021)
Overweight	.---	.---	.---	0.271***	.---	.---	.---	0.280***
				(0.012)				(0.028)
Obese	.---	.---	.---	0.386***	.---	.---	.---	0.393***
				(0.023)				(0.049)
Severely Obese	.---	.---	.---	0.422***	.---	.---	.---	0.433***
				(0.040)				(0.085)
Drinking								
Light	.---	.---	.---	0.011	.---	.---	.---	0.012
				(0.017)				(0.013)
Regular	.---	.---	.---	-0.010	.---	.---	.---	0.004
				(0.022)				(0.018)
Moderate	.---	.---	.---	-0.008	.---	.---	.---	0.021
				(0.022)				(0.018)
Heavy	.---	.---	.---	-0.057***	.---	.---	.---	0.008
				(0.021)				(0.018)
Smoking								
Light	.---	.---	.---	0.031*	.---	.---	.---	0.045***
				(0.018)				(0.015)
Regular	.---	.---	.---	0.186***	.---	.---	.---	0.139***
				(0.019)				(0.016)
Moderate	.---	.---	.---	0.274***	.---	.---	.---	0.214***
				(0.017)				(0.017)
Heavy	.---	.---	.---	0.248***	.---	.---	.---	0.201***
				(0.039)				(0.032)
Drug use								
Marijuana	.---	.---	.---	0.063***	.---	.---	.---	0.045***
				(0.011)				(0.010)
Other drugs	.---	.---	.---	0.133***	.---	.---	.---	0.082***
				(0.019)				(0.017)
Criminal Activity								
Low	.---	.---	.---	0.006	.---	.---	.---	0.054***
				(0.013)				(0.011)
Moderate	.---	.---	.---	0.056***	.---	.---	.---	0.061***
				(0.022)				(0.018)
High	.---	.---	.---	0.003	.---	.---	.---	0.056**
				(0.031)				(0.026)
Extensive and Versatilty	.---	.---	.---	0.056*	.---	.---	.---	0.078***
				(0.034)				(0.028)
Constant	1.829***	2.160***	2.085***	2.093***	1.855***	2.168***	2.138***	2.057***
	(0.008)	(0.015)	(0.015)	(0.020)	(0.011)	(0.030)	(0.030)	(0.032)
Number of observations	56,176	56,176	56,176	56,176	56,176	56,176	56,176	56,176
Number of cases	4,156	4,156	4,156	4,156	4,156	4,156	4,156	4,156

Note. Standard errors are in parentheses.

*** p < .01 ** p < .05

Table 3. Random-effect coefficients (AR1): Self-rated health regressed on educational attainment, cognitive ability, and select non-cognitive traits, NLSY97.

	White males		White females		Black males		Black females		Hispanic males		Hispanic Females	
Educational attainment	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
High school graduate	0.033	-0.037	0.011	-0.042	0.028	-0.008	0.060	0.072	0.025	0.041	0.048	0.042
	(0.025)	(0.028)	(0.029)	(0.031)	(0.037)	(0.040)	(0.041)	(0.045)	(0.043)	(0.047)	(0.044)	(0.049)
Some college	-0.024	-0.033	-0.048**	-0.045	0.029	0.019	0.045	0.066	-0.110**	-0.090**	0.006	0.006
	(0.023)	(0.023)	(0.023)	(0.023)	(0.041)	(0.041)	(0.039)	(0.039)	(0.045)	(0.045)	(0.043)	(0.043)
Two-year degree	-0.035	-0.083	-0.118**	-0.115**	-0.039	-0.081	0.045	0.073	-0.134	-0.054	-0.093	-0.065
	(0.053)	(0.054)	(0.057)	(0.057)	(0.104)	(0.105)	(0.093)	(0.094)	(0.118)	(0.118)	(0.100)	(0.102)
Four-year degree or more	-0.127***	-0.131***	-0.190***	-0.165***	0.029	-0.025	-0.174***	-0.163**	-0.234***	-0.157	-0.073	-0.035
	(0.036)	(0.037)	(0.034)	(0.036)	(0.086)	(0.086)	(0.066)	(0.067)	(0.084)	(0.084)	(0.070)	(0.072)
Cognitive ability												
20th Percentile	-0.078	-0.077	-0.195***	-0.162***	0.029	0.027	0.076	0.092	-0.135	-0.135	0.030	0.013
	(0.058)	(0.054)	(0.059)	(0.055)	(0.066)	(0.063)	(0.074)	(0.068)	(0.077)	(0.072)	(0.075)	(0.071)
40th Percentile	-0.112*	-0.106*	-0.028	-0.017	-0.063	-0.068	0.127	0.114	0.082	0.029	-0.140	-0.124
	(0.062)	(0.057)	(0.063)	(0.059)	(0.082)	(0.079)	(0.092)	(0.084)	(0.097)	(0.089)	(0.087)	(0.083)
60th Percentile	-0.173***	-0.159***	-0.139**	-0.110**	0.079	0.079	-0.076	-0.068	0.021	0.023	-0.100	-0.120
	(0.054)	(0.050)	(0.056)	(0.052)	(0.081)	(0.078)	(0.090)	(0.082)	(0.085)	(0.079)	(0.085)	(0.080)
80th Percentile	-0.252***	-0.210***	-0.272***	-0.224***	0.022	0.027	-0.029	-0.020	-0.157**	-0.154**	-0.242***	-0.223***
	(0.045)	(0.043)	(0.048)	(0.045)	(0.076)	(0.073)	(0.078)	(0.071)	(0.075)	(0.070)	(0.083)	(0.079)
Task orientedness												
20th Percentile	-0.008	-0.000	-0.154***	-0.119**	-0.156**	-0.149**	-0.016	-0.013	-0.028	-0.056	0.038	0.049
	(0.048)	(0.045)	(0.059)	(0.055)	(0.076)	(0.073)	(0.088)	(0.080)	(0.084)	(0.078)	(0.086)	(0.081)
40th Percentile	-0.183***	-0.172***	-0.140**	-0.107*	-0.168**	-0.164**	0.018	0.015	-0.177**	-0.168**	0.057	0.076
	(0.050)	(0.047)	(0.059)	(0.055)	(0.078)	(0.074)	(0.087)	(0.080)	(0.087)	(0.080)	(0.090)	(0.086)
60th Percentile	-0.183***	-0.159***	-0.176***	-0.134**	-0.068	-0.057	0.004	-0.015	-0.225**	-0.216***	0.036	0.057
	(0.048)	(0.045)	(0.056)	(0.052)	(0.081)	(0.077)	(0.088)	(0.081)	(0.089)	(0.082)	(0.088)	(0.084)
80th Percentile	-0.269***	-0.236***	-0.262***	-0.189***	-0.222***	-0.206***	-0.161	-0.146	-0.350***	-0.350***	-0.067	-0.014
	(0.054)	(0.051)	(0.056)	(0.052)	(0.081)	(0.078)	(0.087)	(0.080)	(0.094)	(0.087)	(0.093)	(0.089)
Sociability												
20th Percentile	-0.143***	-0.109**	-0.129**	-0.111**	0.056	0.042	-0.177**	-0.178**	-0.063	-0.076	0.031	0.057
	(0.048)	(0.045)	(0.053)	(0.050)	(0.080)	(0.077)	(0.086)	(0.079)	(0.086)	(0.080)	(0.081)	(0.077)
40th Percentile	-0.148***	-0.113**	-0.169***	-0.127**	-0.106	-0.099	-0.184**	-0.175**	-0.093	-0.090	-0.105	-0.081
	(0.051)	(0.048)	(0.054)	(0.051)	(0.087)	(0.084)	(0.088)	(0.080)	(0.094)	(0.087)	(0.084)	(0.079)
60th Percentile	-0.172***	-0.125***	-0.178***	-0.123**	-0.052	-0.047	-0.171*	-0.163**	-0.009	0.002	-0.234***	-0.208**
	(0.049)	(0.046)	(0.056)	(0.052)	(0.080)	(0.077)	(0.087)	(0.080)	(0.088)	(0.082)	(0.088)	(0.083)
80th Percentile	-0.235***	-0.182***	-0.285***	-0.230***	-0.032	-0.029	-0.205**	-0.200***	-0.120	-0.100	-0.350***	-0.292***
	(0.053)	(0.050)	(0.055)	(0.051)	(0.080)	(0.077)	(0.085)	(0.077)	(0.091)	(0.085)	(0.088)	(0.083)
Truancy - 1997	0.194***	0.147***	0.185***	0.120***	0.163**	0.119	0.166**	0.131**	0.210***	0.153**	0.048	0.040
	(0.044)	(0.041)	(0.042)	(0.039)	(0.067)	(0.064)	(0.070)	(0.064)	(0.067)	(0.062)	(0.067)	(0.064)
Number of observations	16,188	16,188	15,237	15,237	7,148	7,148	7,426	7,426	5,59	5,59	5,829	5,829
Number of cases	1,223	1,223	1,14	1,14	587	587	571	571	440	440	456	456

Note. Standard errors in parentheses

*** p<0.01 ** p<0.05

Table 4. Coefficients for Self-rated health regressed on educational attainment and selected time-varying covariates, NLSY97 Full Sample.

	OLS		Fixed Effects-AR(1)	
Variables	(1)	(2)	(3)	(4)
Aging	0.048***	0.027***	0.035***	0.033***
	(0.001)	(0.001)	(0.001)	(0.001)
Educational Attainment				
High school graduate	-0.038***	-0.086***	0.051***	0.041***
	(0.009)	(0.010)	(0.011)	(0.012)
Some college	-0.204***	-0.129***	0.038***	0.020*
	(0.008)	(0.008)	(0.011)	(0.011)
Two-year degree	-0.274***	-0.227***	-0.004	-0.010
	(0.020)	(0.020)	(0.025)	(0.026)
Four-year degree or more	-0.537***	-0.373***	-0.055***	-0.054***
	(0.011)	(0.012)	(0.017)	(0.018)
Marital Status				
Married	.---	-0.021**	.---	-0.023**
		(0.008)		(0.011)
Separated/Divorced	.---	0.059***	.---	-0.053**
		(0.019)		(0.022)
Main Activities				
Employed	.---	-0.089***	.---	0.016**
		(0.007)		(0.007)
Enrolled in school	.---	-0.122***	.---	0.012
		(0.008)		(0.008)
Body Mass Index				
Under weight	.---	0.049***	.---	0.054***
		(0.013)		(0.014)
Over weight	.---	0.103***	.---	0.050***
		(0.007)		(0.008)
Obese	.---	0.355***	.---	0.164***
		(0.010)		(0.012)
Severely Obese	.---	0.654***	.---	0.308***
		(0.011)		(0.017)
Drinking				
Light	.---	-0.012	.---	-0.015
		(0.012)		(0.010)
Regular	.---	-0.034**	.---	-0.001
		(0.015)		(0.013)
Moderate	.---	-0.036**	.---	0.009
		(0.015)		(0.013)
Heavy	.---	-0.043***	.---	0.038***
		(0.015)		(0.013)
Smoking				
Casual	.---	0.067***	.---	0.069***
		(0.013)		(0.011)
Light	.---	0.206***	.---	0.134***
		(0.013)		(0.013)
Regular	.---	0.325***	.---	0.186***
		(0.012)		(0.014)
Heavy	.---	0.396***	.---	0.215***
		(0.025)		(0.025)
Drug use				
Marijuana	.---	0.073***	.---	0.051***
		(0.008)		(0.008)
Other drugs	.---	0.113***	.---	0.071***
		(0.014)		(0.013)
Criminal Activity				
Low	.---	0.006	.---	0.051***
		(0.009)		(0.009)
Moderate	.---	0.062***	.---	0.069***
		(0.016)		(0.015)
High	.---	0.065***	.---	0.049**
		(0.023)		(0.023)
Extensive and Versatilty	.---	0.102***	.---	0.089***
		(0.025)		(0.026)
Constant	1.866***	1.902***	1.838***	1.718***
	(0.006)	(0.011)	(0.006)	(0.009)
Observations	108,365	108,365	99,394	99,394
Cases	8,971	8,971	8,852	8,852

Note. Standard errors in parentheses

*** p<0.01 ** p<0.05

Table 5. Coefficients for the effects of educational attainment on self-rated health by race and sex, NLSY97.

A. White males

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	-0.038**	-0.133***	0.062***	0.037
	(0.017)	(0.019)	(0.020)	(0.023)
Some college	-0.261***	-0.202***	0.076***	0.053***
	(0.015)	(0.015)	(0.019)	(0.020)
Two-year degree	-0.282***	-0.277***	0.073	0.043
	(0.035)	(0.035)	(0.045)	(0.046)
Four-year degree or more	-0.554***	-0.413***	0.012	-0.009
	(0.021)	(0.021)	(0.030)	(0.031)
Observations	29,898	29,898	27,448	27,448
Cases	2,407	2,407	2,41	2,41

B. White females

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	-0.031	-0.123***	0.047**	0.038
	(0.020)	(0.021)	(0.023)	(0.026)
Some college	-0.266***	-0.153***	0.012	-0.010
	(0.016)	(0.016)	(0.020)	(0.020)
Two-year degree	-0.373***	-0.297***	-0.024	-0.030
	(0.036)	(0.035)	(0.045)	(0.046)
Four-year degree or more	-0.665***	-0.426***	-0.052	-0.053
	(0.021)	(0.022)	(0.029)	(0.031)
Observations	28,040	28,040	25,751	25,751
Cases	2,241	2,241	2,250	2,250

C. Black males

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	-0.054**	-0.090***	0.035	-0.007
	(0.024)	(0.026)	(0.030)	(0.033)
Some college	-0.117***	-0.092***	0.022	0.004
	(0.024)	(0.024)	(0.037)	(0.037)
Two-year degree	-0.250***	-0.210***	-0.024	-0.071
	(0.071)	(0.071)	(0.091)	(0.093)
Four-year degree or more	-0.356***	-0.307***	-0.024	-0.098
	(0.040)	(0.041)	(0.067)	(0.069)
Observations	13,456	13,456	12,287	12,287
Cases	1,161	1,161	1,159	1,159

C. Black females

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	-0.023	-0.011	0.072**	0.092**
	(0.027)	(0.028)	(0.032)	(0.036)
Some college	-0.091***	-0.010	0.071**	0.063*
	(0.024)	(0.024)	(0.033)	(0.033)
Two-year degree	-0.103	-0.012	0.086	0.107
	(0.061)	(0.059)	(0.071)	(0.073)
Four-year degree or more	-0.417***	-0.271***	-0.048	-0.032
	(0.035)	(0.036)	(0.054)	(0.056)
Observations	14,279	14,279	13,115	13,115
Cases	1,153	1,153	1,153	1,153

D. Hispanic males

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	-0.110***	-0.117***	-0.005	0.015
	(0.025)	(0.027)	(0.034)	(0.038)
Some college	-0.326***	-0.251***	-0.038	-0.043
	(0.024)	(0.025)	(0.039)	(0.039)
Two-year degree	-0.390***	-0.291***	-0.145	-0.099
	(0.076)	(0.071)	(0.092)	(0.094)
Four-year degree or more	-0.573***	-0.441***	-0.142**	-0.095
	(0.043)	(0.042)	(0.069)	(0.071)
Observations	11,483	11,483	10,508	10,508
Cases	967	967	966	966

E. Hispanic females

	OLS		Fixed Effects-AR(1)	
	(1)	(2)	(5)	(6)
High school/GED	0.093***	0.054*	0.071**	0.093**
	(0.027)	(0.029)	(0.036)	(0.040)
Some college	-0.153***	-0.096***	0.084**	0.081**
	(0.025)	(0.025)	(0.037)	(0.037)
Two-year degree	-0.295***	-0.260***	-0.010	0.025
	(0.061)	(0.061)	(0.080)	(0.083)
Four-year degree or more	-0.375***	-0.245***	0.043	0.091
	(0.039)	(0.039)	(0.060)	(0.064)
Observations	11,209	11,209	10,285	10,285
Cases	913	913	914	914

Note. Standard errors in parentheses. All even numbered models include controls for marital status, main activities, body mass index categories, drinking, smoking, drug use, and criminal offending.

*** p<0.01 ** p<0.05

Appendix A. OLS and multinomial logit coefficients: Educational attainment regressed on race and sex and select cognitive and non-cognitive abilities, 12 years old cohort, NLSY97.

	Total Years of Schooling		High School Graduate		Some College		Two-year degree		Four-year degree	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Race-Sex										
White females	0.603***	0.607***	0.170	0.167	0.263	0.421	-0.225	-0.126	0.831**	1.075***
	(0.174)	(0.157)	(0.352)	(0.361)	(0.337)	(0.357)	(0.433)	(0.455)	(0.334)	(0.367)
Black males	-1.073***	-0.191	-0.264	0.070	-0.451	0.332	-1.733***	-0.987*	-1.668***	-0.404
	(0.217)	(0.206)	(0.329)	(0.353)	(0.318)	(0.354)	(0.555)	(0.590)	(0.387)	(0.433)
Black females	-0.276	0.452**	-0.281	0.019	-0.022	0.727**	-0.711	-0.021	-0.773**	0.393
	(0.201)	(0.191)	(0.353)	(0.370)	(0.331)	(0.361)	(0.458)	(0.494)	(0.362)	(0.406)
Hispanic males	-1.050***	-0.261	-0.405	-0.048	-0.600*	0.185	-1.417***	-0.706	-1.599***	-0.520
	(0.248)	(0.228)	(0.346)	(0.368)	(0.335)	(0.371)	(0.529)	(0.562)	(0.400)	(0.452)
Hispanic females	-0.270	0.360	-0.418	-0.228	-0.116	0.496	-0.501	0.080	-0.570	0.485
	(0.236)	(0.227)	(0.395)	(0.409)	(0.367)	(0.395)	(0.487)	(0.523)	(0.391)	(0.436)
Cognitive ability										
20th percentile	.---	0.639***	.---	0.750**	.---	0.664**	.---	0.577	.---	1.342***
		(0.199)		(0.299)		(0.304)		(0.484)		(0.376)
40th percentile	.---	1.083***	.---	0.901**	.---	1.232***	.---	1.702***	.---	1.885***
		(0.222)		(0.391)		(0.388)		(0.510)		(0.450)
60th percentile	.---	1.460***	.---	1.290***	.---	2.103***	.---	1.728***	.---	2.795***
		(0.189)		(0.445)		(0.433)		(0.572)		(0.480)
80th percentile	.---	2.262***	.---	0.592	.---	2.134***	.---	2.290***	.---	3.709***
		(0.173)		(0.410)		(0.382)		(0.485)		(0.421)
Task-orientedness										
20th percentile	.---	0.336*	.---	0.110	.---	0.447	.---	0.568	.---	0.627*
		(0.199)		(0.307)		(0.309)		(0.474)		(0.357)
40th percentile	.---	0.475**	.---	0.197	.---	0.922***	.---	1.127**	.---	0.744*
		(0.188)		(0.347)		(0.339)		(0.485)		(0.389)
60th percentile	.---	0.568***	.---	0.496	.---	0.887**	.---	0.571	.---	1.067***
		(0.193)		(0.364)		(0.360)		(0.535)		(0.398)
80th percentile	.---	0.677***	.---	0.419	.---	0.763**	.---	1.348***	.---	1.203***
		(0.200)		(0.385)		(0.377)		(0.521)		(0.414)
Sociability										
20th percentile	.---	0.282	.---	0.169	.---	0.447	.---	0.281	.---	0.588
		(0.196)		(0.324)		(0.327)		(0.508)		(0.376)
40th percentile	.---	0.484**	.---	-0.010	.---	0.517	.---	0.793	.---	0.769*
		(0.195)		(0.363)		(0.354)		(0.494)		(0.396)
60th percentile	.---	0.706***	.---	0.744*	.---	0.974**	.---	1.533***	.---	1.517***
		(0.182)		(0.394)		(0.393)		(0.510)		(0.427)
80th percentile	.---	0.387*	.---	-0.507	.---	0.196	.---	0.048	.---	0.489
		(0.201)		(0.331)		(0.320)		(0.495)		(0.367)
Committment	.---	-0.808***	.---	-0.407	.---	-1.016***	.---	-1.165**	.---	-1.361***
		(0.193)		(0.263)		(0.274)		(0.465)		(0.334)
Constant	13.792***	11.641***	1.075***	0.337	1.447***	-0.590*	0.164	-2.146***	1.263***	-2.289***
	(0.121)	(0.228)	(0.219)	(0.333)	(0.210)	(0.347)	(0.257)	(0.542)	(0.214)	(0.434)
Observations	1,295	1,295	1,295	1,295	1,295	1,295	1,295	1,295	1,295	1,295

Note. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix A. Cognitive and non-cognitive ability and educational attainment.

As the inclusion of cognitive and non-cognitive abilities are not particularly commonplace in educational research in sociology, we provide a brief illustration of their importance using data from the cohort of 12 year olds in 1997 in the NLSY – 97. Here we estimate two sets of models, an OLS model predicting total years of education by age 27 and a multinomial logit model predicting different types of educational attainment by the same age. Although results are not dependent upon the choice of cohort, we focus on the 12 year olds in order to identify cognitive and non-cognitive abilities at the earliest opportunity, in this case cognitive ability prior to the teenage years and non-cognitive abilities prior to the modal age of completion of high school (17-18 years of age). Importantly, these also predate the typical first point of demarcation for education gradients in health.

The models include two sets of predictor variables. The first is a set of dummy variables indexing race and sex and we use these a) to establish a benchmark of effect sizes given that these capture a range of social advantages and disadvantages associated with communities, economic circumstances, family structure and process; and b) to assess the degree to which cognitive and non-cognitive ability established in early life can account for such differences. The second set of variables is the indicators of cognitive and non-cognitive ability that we use to assess health dynamics and the association between educational attainment and health. These include cognitive ability, task-orientedness, socialability, and commitment. Results are shown in appendix table A.

Beginning with models predicting total years of schooling, a first model shows large differences across race and sex groups with white females having the highest level of attainment (b = .603, p < .01) and Black (b = -1.073, p < .01and Hispanic males (b = -1.050, p < .01having substantially lower attainment (see model 1). By conventional standards, these effects are quite large, accounting for one-quarter of a standard deviation in the case of white females and just under a half a standard deviation in the cases of Black and Hispanic males. Model 2 includes dummy variables indexing different percentiles of cognitive and non-cognitive abilities. In the former case, the effects are strongly linear and the two higher percentiles show extremely large effects on total years of schooling. In the case of the 60th to 80th percentile, the effect is over half a standard deviation in years of schooling (b = 1.460, p < .01). In the case of being above the 80th percentile, the effect is just under a standard deviation (b = 2.262, p < .01). Even being in the 40th percentile for cognitive ability has effects that are similar in magnitude to the cumulative disadvantage associated with being a Black or Hispanic male. For task orientation, the effects are again substantively linear with the highest percentile showing a fairly large effect, just under a third of a standard deviation (b = .677, p < .01). Commitment shows an even larger effect (-.808, p < .01). Effects are less linear with respect to sociability, but even here there is evidence of substantively large effects (e.g., b = .706, p < .01 for the 60th percentile). As a final issue, the inclusion of cognitive and non-cognitive abilities that are endogenous, almost regardless of the theoretical model that one could logically pose, statistically explain seventy-five to eighty percent of the effects of differentials in years of schooling for Black and Hispanic males and actually turn the null coefficient for Black females positive.

Models 3 through 13 elaborate these points by examining effects on different levels of educational attainment, differentiating those without a high school degree from those a) with a high school degree, b) those with some college, c) those with a two year college degree, d) those with a four-year college degree, and e) those with some graduate school experience or degree. To summarize a considerable amount of information, we highlight four features of the data. First, race-sex differences in educational attainment become more pronounced with advanced degrees. For example, there are no significant differences with respect to high school degree attainment but there are significant and substantively large differences for four-year degree attainment for four of five contrasts and the fifth contrast is large in magnitude and in the expected theoretical direction (i.e., disadvantage for Hispanic females).

Second, the inclusion of measured cognitive and non-cognitive abilities account for race-sex differences in a large number of instances, with the consistent exception of the advantages seen for white females. Extent of statistical explanation is clearly variable, but is typically greater than fifty percent and in many instances is one hundred percent (e.g., four-year degree attainment among Black females). Third, the effects of cognitive ability strongly increase in magnitude with more advanced degrees. For example, being above the 80th percentile for cognitive ability increases from .592 (*ns*) for high school graduation to 2.134 ($p < .01$) for some college to 2.290 ($p < .01$) to 3.709 ($p < .01$) for a four-year college degree or greater. Equally interesting, the effect of being simply above the 40th percentile for cognitive ability is larger than even the largest race-sex disadvantage regardless of the attainment contrast considered. Fourth, the effects for non-cognitive abilities, while somewhat smaller in magnitude, show the same basic pattern of effects. For the highest level of task-orientedness, effect sizes increase from .419 (*ns*) for high school graduation to 1.203 ($p < .01$) for a four-year degree or greater. For sociability, effect sizes increase from .744 (*ns*) to 1.517 ($p < .01$). Effects of commitment increase linearly from -.047 (*ns*) to -1.361 ($p < .01$).

To summarize, analyses of cognitive and non-cognitive abilities and educational attainment show substantively large effects that buttress our argument that such abilities are fundamental precursors to processes of educational attainment. Translating coefficients into odds-ratios reinforces this point. Being in the highest percentile category for cognitive ability increases the likelihood of a four-year college degree by over *40 times*, being in the highest percentile category for being task oriented increases likelihood by*3.3 times*, being in the highest percentile category for sociability increases likelihood by *4.6 times* and having a particularly low level of commitment decreases likelihood by *75 percent*. Considering them as joint effects, the evidence is strong that cognitive and non-cognitive abilities formed early in life are fundamental predictors of education attainment and may explain important, frequently referenced, sociodemographic differences in educational attainment.