THE EVOLVING IMPORTANCE OF EARLY-LIFE HEALTH FOR THE REPRODUCTION OF EDUCATIONAL DISADVANTAGE ACROSS BIRTH COHORTS

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ABSTRACT

Across the last five decades, the United States has experienced rising social inequality that elicits concern about children’s future life chances. Increasingly unequal family and economic contexts suggest that children of disadvantaged families might face lower social mobility prospects across birth cohorts. However, the situation is not entirely bleak: alongside inequality’s growth, a number of policies have increased educational opportunities and improved the floor level of health.

This dissertation asks how these competing forces might have reshaped the reproduction of educational disadvantage across birth cohorts. In particular, it focuses on how rising inequality and “rising tides” of wellbeing might have revised the importance of child health as a channel through which educational disadvantage is passed from parents to children. I examine two related questions in successive chapters. First, has the association between mother’s education and child health changed across birth cohorts? Second, has the association between child health and educational attainment changed across birth cohorts?

The first two empirical chapters address the first question. Using data from the National Health Interview Surveys (NHIS), I examine whether the maternal gradient in children’s subjective health has changed across 1965-2013 birth cohorts. I find that maternal education has become a weaker predictor of subjective health, but that this overall decline also masks important heterogeneity in explanatory pathways. The second empirical chapter extends this question to see if these declines extend to another measure of health, namely children’s reported conditions. Higher maternal education means higher probabilities of having a condition, but this relationship has also attenuated across birth cohorts.
In the final empirical chapter, I examine whether child health’s implications for life chances have changed across cohorts. Using data from the Panel Study of Income Dynamics (PSID), I find that early-life health (as measured through low birth weight) became a weaker—and, in some cases, non-important—predictor of educational attainment across 1940-1985 birth cohorts. Taken together, this dissertation’s findings suggest that “rising tides” have overwhelmed rising social inequality, rendering child health a less important channel for the transmission of educational attainment from parents to children.
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Chapter 1: Introduction

Since the 1970s, the United States has witnessed immense growth in social and economic inequality (Blank 2011; Carlson and England 2011). This growth has concentrated even more advantage among the already-most-well-off families and has potentially strengthened the influence of parental socioeconomic resources on children’s wellbeing. Across cohorts, this rising inequality might have introduced new impediments to less-advantaged children’s ability to escape their humble origins. But the situation is not completely bleak: the last several decades have also seen improvements in the floor level of wellbeing due to rising educational attainment as well as advances in medical care and nutrition (Currie 2008; Mare 1995; Snyder and Dillow 2013). These improvements, in contrast to rising inequality, suggest that early-life circumstances may have weaker effects across generations and throughout individuals’ lives. What has been the net effect of these countervailing macrosocial forces on children’s life chances?

In this dissertation, I focus on child health as a barometer of life chances. A large body of research demonstrates that children of less-educated parents tend to be sicker than children of more-educated parents and that sick children tend to obtain less schooling than healthy children (Case, Lubotsky, and Paxson 2002; Case, Fertig, and Paxson 2005; Case and Paxson 2010; Conley and Bennett 2000, 2001; Conley, Strully, and Bennett 2003a; Persico, Postlewaite, and Silverman 2004). Yet the ways in which these reciprocal relationships between education and health have changed across twentieth- and twenty-first-century birth cohorts is unknown.

Examining trends across birth cohorts offers some insight into future inequality. A growing concentration of advantage among the most-well-off families can impede the ability of the worst-off children to improve their socioeconomic circumstance. Indeed, early evidence
indicates that social mobility may have decreased alongside recent rising inequality (Beller 2009; Mitnik, Cumberworth, and Grusky 2013). Children born into humble beginnings are likely to remain there throughout their lives. But, as I argue throughout this dissertation, the “rising tides” of basic health and education improvements might have weakened the child health consequences of education and the educational consequences of child health, buoying children’s life chances.

Situated primarily in the stratification and life-course literatures, my dissertation interrogates whether the importance of poor child health for the reproduction of educational disadvantage across generations has evolved alongside rising social inequality and improving levels of health and education. The primary contribution of my dissertation is a consideration of the dynamics of this relationship over mid-twentieth to early-twenty-first century American birth cohorts. Given the unavailability of rich data containing information about parental socioeconomic circumstance, child health status, and adult educational attainment spanning a wide range of cohorts, I break my question into two broad questions: (1) Has the association between mother’s education and child health changed across birth cohorts? (2) Has the association between child health and educational attainment changed across birth cohorts?

In the remainder of this introduction, I briefly review theoretical and empirical insights on the role of child health in social mobility and the reproduction of educational advantage. I then provide a broad overview of why we might expect change in each of the association between maternal education and child health and in the association between child health and educational attainment. I conclude by previewing the dissertation’s three empirical chapters.
Child health in inter- and intragenerational processes

What is child health?

“Child health” is a multifaceted concept and includes a range of exposures and experiences across the first decades of individuals’ lives. As noted by others (e.g., Palloni 2006, Mullahy, Robert, and Wolfe 2004), the concept of child health encompasses a diverse grouping of underlying conditions, including in utero experiences, birth weight, chronic conditions, and mental health. The types of conditions that fall under the broad label of “child health” vary in their etiologies and forms: they can be cellular, functional, clinical or subclinical, and/or genetic (Mullahy, Robert, and Wolfe 2004). In this dissertation, I focus on three distinct measures of child health: subjective health, reported health conditions, and birth weight. These three indicators of child health are the most studied and are of concern to both researchers and policymakers. They are also measured consistently across time, which permits an examination of trends over a substantial number of birth cohorts. In each analytic chapter, I explain why I use a particular measure of child health.

Regardless of the specific manifestation or indicator, child health is relevant to sociologists, demographers, and policymakers in three senses: (1) as an outcome in its own right; (2) as a visible consequence of disadvantage in the previous generation; and (3) as an antecedent of later-life outcomes. Each of these aspects of child health is intimately tied to the others, and I emphasize all three throughout this dissertation. However, I stress the latter two senses in arguing why we should care about cohort trends in the child health consequences of parental (maternal) education and in the educational consequences of child health.
Why care about child health in the reproduction of disadvantage?

For over a half century, a major stream of sociological research has focused on the ways in which parents help determine their children’s life chances and, therefore, pattern future inequality (e.g., Blau and Duncan 1967; Featherman and Hauser 1978; Sewell, Haller, and Portes 1969). Subsets of this broader literature have called for greater attention to the ways in which childhood circumstances are involved within both intergenerational and intragenerational dynamics. For example, Melvin Kohn (1959, 1963) forcefully argued that differences in parent-child dynamics by social class might help to transmit socioeconomic circumstance from parent to child. Life-course sociologists such as Glenn Elder (1985) emphasized the timing, sequence, and duration of early-life events as determinants for later-life outcomes.

During the last two decades, an additional focus within the inequality/stratification literature has emerged. A growing body of research (e.g., Case, Lubotsky, and Paxson 2002; Case and Paxson 2010; Currie 2009; Palloni 2006; Palloni et al. 2009) has highlighted the importance of child health in the reproduction of disadvantage across generations. This research focuses on two empirical regularities. First, early-life contexts shaped by parental socioeconomic resources influence child physical and mental health. Second, child health influences adult socioeconomic attainment. Putting these two insights together, Palloni (2006) estimates that child health (as defined as birth weight and childhood chronic conditions) explains about nine percent of the association between parental social class and son’s social class.

Moving from the broad categories of “social mobility” and “socioeconomic circumstance” to educational mobility and educational attainment, we see the same basic dynamics as described above. Parental education—particularly mother’s education (which is the primary focus of my first two analytic chapters)—influences child health (Case, Fertig, and

Why are parental (maternal) education, child health, and educational attainment linked? According to the human capital perspective within social epidemiology, each year of educational attainment carries improved knowledge, greater cognitive and non-cognitive skills, and greater psychological resources that buffer against stress and negative health events (see Ross and Mirowsky 2003; Ross and Wu 1995). Mothers can use these human capital resources to prevent illness, recognize early symptoms, and navigate health systems to promote their child’s health. More-educated mothers are also more likely to have high incomes, a second parent present, and fewer children than are less-educated mothers. High income and these family configurations tend to promote child health (Currie 2009; McLanahan and Percheski 2008; Ziol-Guest and Dunifon 2014).

In turn, those who experience poor health during childhood have lower educational attainment than their healthier peers. For example, Conley and Bennett (2000) find that low birth-weight individuals are 44 to 87 percent less likely to complete high school compared to their healthy birth-weight peers. Although explanations for child health’s influence on educational attainment vary across studies, the emerging consensus is that poor child health impairs cognitive development (Boardman et al. 2002) and worsens later-life health (Barker 1995; Currie et al. 2010). Poor cognitive development and poor later childhood health, in turn, influence educational attainment. Sicker children tend to be absent from school more often than healthier children, which impedes their educational attainment (Grossman and Kaestner 1997).¹

¹ Academic achievement difficulty and school absence are also part of feedback processes in which they are causes and consequences of reduced cognitive skill formation. For example,
Students with reduced cognitive skills resulting from poor early-life health perform worse academically than their healthy weight counterparts (Boardman et al. 2002). Sicker students’ impaired academic participation and performance, in turn, contribute to their lower educational attainment than their healthier peers (Jackson 2009).

**Have dynamics changed across birth cohorts?**

Despite the intergenerational consequences of child health, little is known about the ways in which growing social and economic inequality may reshape the importance of child health as a mediator in the reproduction of educational disadvantage. Research almost exclusively examines the importance of child health in this process as a snapshot. That is, most studies examine the parental education - child health, and child health - adult educational attainment relationships cross-sectionally or within one particular cohort. But evidence suggests that the assumption of cohort invariance may not be tenable. As I describe in this introduction and in each of the empirical chapters, rising inequality and rising floor levels of health and educational attainment across birth cohorts have the potential to reshape the contribution of child health to the transmission of educational disadvantage from parents to their children.

**Why focus on cohorts?**

The primary contribution of my dissertation is the introduction of cohort variation to sociological understandings of the importance of poor child health in the reproduction of educational disadvantage. Children from different birth cohorts grow up during diverse socioeconomic climates, enjoy different probabilities of having highly educated parents, face different health risks, enjoy access to different health care resources, and experience different paths or barriers to educational opportunities than one another. As I explain in my analytic lower cognitive skills might prevent a student from engaging in academic material. Non-engagement might prevent additional cognitive skill development, thereby accumulating additional disadvantage throughout a child’s time in school.
chapters, each of these developmental, social, and health experiences—and, therefore, an individual’s birth cohort—has dramatic potential to reshape the relationship between socioeconomic attainment and health over the life course and, therefore, the reproduction of educational advantage across generations. Considering these differences across birth cohorts offers a window on the implications of emergent macrosocial patterns for children’s life chances.

Examining change in the social world is a core part of sociological research, and the cohort is an important unit of analysis for examining change. Ryder (1965) persuasively argued for the importance of considering cohorts, writing: “each cohort acquires coherence and continuity from the distinctive development its constituents and from its own persistent macroanalytic features” (p. 843).

Although period changes might also affect the production of child health and its educational consequences, health is largely constructed on the cohort level. Other than for acute infections—which have become increasingly rare in the United States in the twentieth and twenty-first centuries—health is often the result of accumulated risks and exposures (Currie 2009; Delaney and Smith 2012). Moreover, many health interventions also are cohort-focused because they were introduced to children of different ages at different years (Currie 2008). And individuals tend to attain schooling alongside those born around the same time as them.

Accordingly, the life course perspective emphasizes that individuals experience their lives within a set of social, cultural, and historical contexts shared by others in their birth cohort (Gee, Pavalko, and Long 2007; Elder, Johnson and Crosnoe 2003), especially by others in their birth cohort (Ryder 1965). Elder and subsequent life course sociologists reveal how individuals’ wellbeing—including socioeconomic and health conditions—depends on earlier points in an individual’s life (Elder 1985; Elder, Johnson, and Crosnoe 2003; Elder and Shanahan 2007).
Why focus on education?

As noted above, I focus on the cohort trends in the contribution of poor child health to the reproduction of educational disadvantage across generations. Historically, sociological research has focused on social class mobility across generations (usually measured by occupational standing), whereas economics research has focused on income mobility across generations. Despite these primary foci, the relationship between educational attainment in one generation and educational attainment in the next has remained a vital current in stratification research (e.g., Rafferty, and Bell 1993; Breen 2010; Breen and Jonsson 2005). Sociologists examine educational mobility in addition to occupational mobility because education helps to determine income, wealth, health, and happiness. Education is both an end in itself and a determinant of adult wellbeing.

Additionally, from a practical point of view, educational attainment is a more stable measure of socioeconomic resources than is income or occupation. For most individuals, educational attainment is fixed after a certain age (e.g., 25 years or 30 years), but income, wealth, and occupational standing fluctuate over the life course. Therefore, the data requirements for examining child health as a cause and consequence of educational attainment are substantially less onerous than for income and occupation.

Why expect change across cohorts?

We might expect an evolving importance of child health in the reproduction of disadvantage across twentieth- and twenty-first-century birth cohorts. A number of emerging macrosocial patterns have the potential to reshape the contributions of child health to social mobility in countervailing directions. In this dissertation, I organize these sets of changes under
two broad umbrellas: rising rides and rising inequality. I summarize these macrosocial changes in their implications for cohort variation in Figure 1.1.

[Figure 1.1 about here]

Rising tides

First, what I deem “rising tides” improved the floor level of children’s wellbeing through health improvements/medical advances and educational expansion. For example, across the twentieth century, children enjoyed cleaner air and water (Cutler and Miller 1999) and cheaper and more effective vaccines (Smith 1999). A number of legislative policies expanded children’s access to medical care. Pregnant women, infants, and young children became eligible for Medicaid coverage in 1984; in 1990, eligibility expanded for older children and for families earning up to 133 percent of the federal poverty line (Currie 2008). Additional expansions occurred during the 1990s (starting with programs targeted toward older children) and included the introduction of the State Child Health Insurance Program (SCHIP) in 1996. By 2014, children made up nearly 48 percent of Medicaid recipients (Department of Health and Human Services 2015).

Children were also able to receive better nutrition through the Supplemental Nutritional Assistance Program (SNAP), the Infant Health and Development Program (IHDP) and Supplemental Feeding Program for Women, Infants, and Children (WIC). Although there is some debate, evidence suggests that program participation improves children’s health (Kreider et al. 2012). These policies did not affect only a small segment of the American population. By the turn of the twentieth century, for example, more than half of American children resided in a household that received food stamps (Rank and Hirschl 2009).
Such nutritional interventions increased babies’ birth weights and reduced the number of low and very-low birth-weight babies across cohorts. In 1970, 7.9 percent of children were born weighing under 2,500 grams (the clinical threshold for “low birth weight”). By 1980, this percent fell to 6.8 percent. Increased mean birth weights and improved low birth-weight children’s survival prospects across the twentieth century (Kramer et al. 2002) suggest that nutrition interventions have had some impact on children’s health. But there is some evidence of a slowdown or reversal in these trends. The prevalence of low birth-weight births increased once again starting in the 1980s (Child Trends Databank 2015; Mathews and MacDorman 2013). However, this “worsening” of babies’ health actually reflected medical improvements, such as a decrease in the age of viability, an increase in pre-term infant survival, and an increase in the prevalence of multiple-child births.

[Figure 1.2 about here]

Meanwhile, chronic and mental health conditions replaced infectious disease as the dominant causes of childhood disease (Case and Paxson 2009; Delaney and Smith 2012; Finch and Crimmins 2004). Figure 1.2 graphs a number of Smith’s (2009) estimates of Panel Study of Income Dynamic (PSID) respondents’ retrospective reports of childhood illness. The panel on the left shows that children born in more recent years were substantially less likely to suffer from measles and mumps than their counterparts born in earlier decades. The majority of children born in the 1930s and 1940s experienced measles and mumps (in addition to other infectious diseases). However, with the introduction of vaccines in the 1960s and other improvements in wellbeing, less than 10 percent of those born 1977-1986 experienced those two conditions.

But children born more recently were more likely to experience asthma, allergies, and depression than those born earlier. Between 1930s and 1970s birth cohorts, there was a five-fold
increase in the percent of children with asthma and a seven-fold increase in the percent with depression. Despite this rapid increase, the overall prevalence remained relatively low compared to the prevalence of infectious diseases during the first half of the twentieth century: Figure 1.2 shows that, among children born between 1977 and 1986, only 12.9 had asthma and 7.3 percent were depressed. Even by other summary measures, such as height and subjective health, children became healthier across the twentieth and twenty-first centuries (Case and Paxson 2010; Rashad 2008).

Changes in the type of illnesses that children faced may have lead to a weaker association between child health and adult socioeconomic attainment across the twentieth century. Whereas the connections between low birth weight and impaired cognitive development (Matte et al. 2010) and between infectious diseases and impaired cognitive development have been demonstrated (Finch and Crimmins 2004, 2006; Epping, Fincher, and Thornhill 2010), a similar relationship between chronic conditions and cognitive function has not (Haas and Fosse 2008). If chronic conditions do not affect one of the primary pathways throughout which child health impairs educational attainment, the educational consequences of poor child health might have weakened across birth cohorts.

**Educational attainment**

Across the twentieth century, individuals have attained more schooling in part due to the rapid expansion in two- and four-year colleges beginning in the 1960s (Mare 1995; Snyder and Dillow 2013). Figure 1.3 illustrates increases in educational attainment across 1911-1985 birth cohorts using data from the National Center for Education Statistics (Snyder and Dillow 2013). Across twentieth-century birth cohorts, a growing share of the population graduated from high school. Whereas about 40 percent of Americans born in the 1910s graduated from high school,
more than 80 percent born in the early 1980s did. Similarly, the percentage of persons obtaining at least a bachelor’s degree ballooned from about 6 percent to 33 percent over the same birth years.

[Figure 1.3 about here]

Women were particularly able to take advantage of new schooling opportunities afforded by educational expansion. About 40 percent of women born at the turn of the twentieth century graduated from high school. By 1930 birth cohorts, 60 percent of women completed high school, a number that grew to more than 80 percent for women born in the 1960s (Mare 1995). Even larger relative cohort increases are observed for women completing some college: the percent falling into this category rose from 20 percent at the turn of the twentieth century to about 55 percent born in 1960 (Mare 1995; Snyder and Dillow 2013). In 1959-1960, women earned about 35 percent of bachelor degrees; by 2004, they earned about 58 percent of degrees (Buchmann and DiPrete 2006).

One feature of educational expansion is that it opens schooling opportunities to larger segments of society. Prior studies find that educational mobility relative to parental educational attainment has increased across twentieth-century birth cohorts (Breen 2010; Hout 2012; Pfeffer and Hertel 2015). Only the most socioeconomically and health-advantaged individuals born in the first several decades of the twentieth century could graduate from high school and continue to postsecondary schools. However, as enrollment opportunities increased, less-privileged children increasingly became able to obtain a high school diploma and enter postsecondary education (Breen 2010; Hout 2012).

Thus rising educational attainment has three main implications for the relationship between maternal education and child health and for the relationship between child health and
educational attainment. First, higher levels of educational attainment might be a weaker marker for the types of advantages (skill, knowledge, income) for mothers of children born in more recent years than those born earlier in the decade. This pattern means that maternal education’s influence on child health might have weakened across cohorts. Second, lower educational attainment (e.g., high school non-completion) may have become a stronger marker for unobserved disadvantage in health or skill. Women who have been unable to complete high school despite increased opportunities are likely particularly disadvantaged. This pattern implies the opposite trend as the previous implication, namely that maternal education’s influence on child health might have strengthened across cohorts. The third implication concerns the educational consequences of poor child health. Individuals who were sick as children might have been one of the disadvantaged groups able to take advantage of new educational opportunities. My analytic chapters empirically examine each of these possibilities.

**Rising inequality**

Rising social inequality left children of more-educated mothers living in increasingly different home contexts than children of less-educated mothers. Rising income inequality has dramatic potential to modify the influence of parental education on child health. More-educated parents tend to be richer parents, and income offers access to health-promoting resources, such as safer neighborhoods, better health care, and better nutrition (Currie 2009). Across cohorts, the association between education and income likely strengthened. Individuals have increasingly enjoyed greater economic returns to schooling across the second half of the twentieth century; for example, the college wage premium more than doubled between 1980 and 2000 (Perna 2003).
Furthermore, McLanahan (2004, 2013) documents the “diverging destinies” of American children as advantaged families rapidly gain more resources while less advantaged families face a diminishing stock of resources. For example, in 1960, about five percent of children with mothers in the top education quartile lived with a single mother compared to about 15 percent of children in the bottom quartile. By 2000, shares grew to about eight percent and 45 percent, respectively.

Not only do children living with more-educated mothers increasingly have access to more economic and non-economic resources than they had in the past, parental use of accrued resources also became more disparate across cohorts. Socioeconomically advantaged parents became increasingly engaged in a “reproduction project” (Mitnik, Cumberworth, and Grusky 2013) or “rug rat race” (Ramey and Ramey 2010) to ensure the transmission of advantage to their offspring. Despite differences in terms, both refer to processes in which advantaged families act intentionally to use their resources in ways to foster their children’s life chances relative to other children.

Regardless of the intentionality of parental behaviors, the most advantaged families have used their growing share of economic and noneconomic resources more effectively across time. For example, Kornich and Furstenberg (2011) use data from the Consumer Expenditure Survey to show that more-advantaged families increased child-oriented spending more than less-advantaged families did. Meanwhile, education gaps in time spent with children have widened across time (Sandberg and Hofferth 2001, 2005). In 1985, college-educated mothers spent about 1.8 more hours per week engaged in childcare than less-educated mothers; by 2003, this disparity had grown to 6.7 hours (Hurst 2010). These divergent time and money investments have the potential to exacerbate a “development gradient” in which more socioeconomically advantaged
children already enjoy more health- and education-promoting child-directed play than less-advantaged children (Kalil, Ryan, and Corey 2012; Ziol-Guest and Dunifon 2014). The increasing resources implied by each year of parental schooling mean that the health effects of parental schooling might have strengthened across birth cohorts.

**Putting the arguments back together**

Taken together, empirical trends in health, education, and social inequality offer conflicting hypotheses about the importance of poor child health as a channel for the reproduction of educational disadvantage across generations. On one hand, rising inequality and advantaged families’ response to inequality suggests that maternal education might have become a stronger influence on child health across birth cohorts. All else equal, this increase implies that, across cohorts, poor child health has become a more important channel in the intergenerational reproduction of educational disadvantage.

On the other hand, secular growth in individuals’—especially mothers’—educational attainment coupled with improvements in children’s health implies that the relationship between maternal education and child health has weakened across cohorts. Education growth and changes in the types of conditions from which children suffer also suggests that the association between child health and educational attainment may have weakened across cohorts. Taken together, these two prevailing trends each suggest that, across cohorts, child health has become a less important channel in the intergenerational reproduction of educational disadvantage.

**Prior research and trends in social and educational mobility**

To my knowledge, only one study offers evidence on the importance of poor child health in the reproduction of disadvantage across birth cohorts. In a working paper, Blanden and colleagues (2006) investigate the changing importance of cognitive and non-cognitive skills in
income mobility between British cohorts born in 1958 and 1970. Incidental to the primary focus of their study, they find that child health is a modestly weaker contributor to income mobility for individuals born in 1958 than for individuals born in 1970, but the difference is not statistically insignificant. In other words, there is no evidence that the child health importance as pathway for the transmission of adult income levels changed between 1958 and 1970 cohorts.

However, this finding does not directly address how child health’s role in the intergenerational reproduction of educational disadvantage has changed across twentieth- and twenty-first-century American birth cohorts. Educational production and health production patterns differ between the United Kingdom and the United States (Breen and Jonsson 2007; Martinson 2012), and income and education mobility follow different patterns from one another (Bloome and Western 2011). Therefore, it is not immediately clear if evidence from two British cohorts from a period before rapidly growing social inequality in a study that focuses on income mobility will extend to educational mobility trends across American birth cohorts.

Broader income and social mobility trends also only offer limited leverage in predicting what rising tides and rising inequality might mean for cohort trends in the reproduction of educational disadvantage across generations. Evidence on trends in social mobility and the intergenerational transmission of advantage is fairly mixed. There is no necessary relationship between rising inequality and individuals’ mobility prospects, but a number of theoretical and empirical models contend that increasing inequality implies decreasing social mobility (Cameron and Heckman 2001; Hout 2004; Mitnik, Cumberworth, and Grusky 2013; Morgan 2006; Smeeding et al. 2011). Accordingly, some researchers find decreasing income mobility during the twentieth century (i.e. the intergenerational association between parental and offspring income) (e.g., Bloome and Western 2011; Fertig 2005), but others argue that these trends are
overstated due to model sensitivity (e.g., Mayer and Lopoo 2004) and/or are estimated on insufficiently young samples (Beller and Hout 2006).

In the final two decades of the century, trends are even muddier. Some scholars have shown a decrease in intergenerational mobility among recent cohorts (Beller 2009; Ellwood and Kane 2005; Hout 1988), while others have found a continuation of the previous increase (Biblarz and Raftery 1999). Different treatment of family structures and the use of data from one versus both parents may contribute to inconsistent findings across studies (see Beller 2009).

There is some consensus that educational mobility increased during the twentieth century, especially for those born in the middle of the century until 1980s. Yet there are some questions as to whether such trends affected the entire United States population. For example, Bloome and Western (2011) find that, between 1966 and 1979, parental education became only slightly (if at all) less predictive of son’s educational attainment for white Americans, but it became substantially less predictive of son’s educational attainment for black Americans.

Investigations into trends in the intergenerational transmission of advantage also fail to yield a universally increasing or decreasing pattern over time and/or birth cohorts. Mare and Musick (2006) examine whether the intergenerational inheritance of family structure and poverty status has strengthened across time. The authors find that the intergenerational correlation persisted across time without any indication of strengthening or weakening. On the other hand, Maralani and McKee (in progress) provide evidence of an increasing intergenerational correlation in smoking status.

**Overview of analytic chapters**

The primary contribution of my dissertation is to fill this gap and ask whether the importance of child health in educational mobility has changed across mid-twentieth to early-
twenty-first century birth cohorts. As noted earlier, I separate my analyses into two major parts. I first examine whether the association between maternal education and child health has changed across 1965-2013 birth cohorts. I then examine whether the association between child health and educational attainment has changed across 1940-1985 birth cohorts.

[Figure 1.4 about here]

Figure 1.4 summarizes some of the hypothesized pathways through which child health is a channel for the transmission of educational disadvantage from parents to children. This figure illustrates each pathway that examine in my empirical analyses. Therefore, I omit a number of pathways that I cannot examine empirically in my dissertation. The first two empirical chapters focus on the relationship between parental socioeconomic resources (specifically maternal education) and child health. Turney and colleagues (2013) argue that the social determinants of child health and wellbeing are understudied in the American context. The final analytic chapter examines change in the “long arm” of child health by examining whether the educational consequences of low birth weight have evolved across birth cohorts.

Chapter 2: Change and Stability in the Maternal Education Gradient in Child Health: Evidence from 1965-2013 Birth Cohorts

In my first analytic chapter, I focus on the educational gradient in child health. A large body of research has demonstrated that higher levels of maternal education are associated with higher levels of offspring health. Research on the maternal education gradient in child health generally views the strength of the gradient as fixed in magnitude across time and birth cohorts. However, secular trends in health and education might have narrowed the education gradient across birth cohorts, whereas advantaged families’ engagement in a “reproduction project” marked by increased child-focused resource allocation might have offset these gains. Given these
competing possibilities, I use National Health Interview Survey (NHIS) data from children born between 1965 and 2013 to examine cohort trends in the association between maternal schooling and children’s subjective health status. I pay particular attention to the ways in which changes in mediating pathways—namely income and family structure—might account for observed cohort trends.

Chapter 3: Maternal Education Gradient in Reported Childhood Conditions

The next chapter refines the analysis presented in the first analytic chapter and asks if the education gradient in reported health conditions follows the same decline across birth cohorts as the gradient in subjective health. I focus on reported conditions because descriptions of the health of the American population, policy decisions concerning child health, and assessments about whether the nation is making progress towards reducing health inequalities each rely on self- or parental-reported measures (e.g., Centers for Disease Control 2012; Department of Health and Human Services 2010). But as I describe in the chapter, there is a crucial tension in this measure. Reported conditions are a sign of “bad” health exposures to the extent that they reflect negative health events. They are also a sign of “good” health exposures to the extent the detection of treatment can buffer against severe symptoms and potentially reduce poor health’s consequences for the child’s life chances.

Given the lack of prior research on the maternal education gradient in children’s health conditions, I first examine the gradient cross-sectionally. Because mothers must observe and recognize health symptoms, I predict that more-educated mothers will be more likely than less-educated mothers to report that their children have a health condition. I use data on eleven reported health conditions from the NHIS Sample Child files in order to test this hypothesis. I conclude by asking whether this gradient has weakened across 1979-2013 birth cohorts in light
of rising educational attainment and expanded health knowledge. Considerations of cohort trends supplement Chapter 2’s findings and help to uncover why the likelihood of having a health condition varies across levels of maternal education.

Chapter 4: Birth weight and educational attainment across birth cohorts

My first analytic chapters show that maternal educational attainment has become less associated with child health across birth cohorts. But what are the longer-term implications of this declining inequality? Diminishing or strengthening educational consequences of low birth weight have the ability to amplify or offset the declining importance of child health for intergenerational cycles of disadvantage. Given a rich tradition of sociological literature focusing on low birth weight’s association with reduced educational attainment, I focus on this aspect of child health. I use data from Panel Study of Income Dynamics (PSID) respondents born between 1940 and 1985. After charting cohort trends in the association between low birth weight and total educational attainment, I focus on whether change occurred at key education transitions. For example, I predict that low birth-weight individuals might have become more likely to complete high school but not more likely to graduate from college.
**TABLES AND FIGURES**

**Figure 1.1.** Summary of example changes and their implications for child health’s importance as a mediator in social mobility

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Figure 1.2. Cohort trends in specific childhood infectious and non-infectious illnesses, 1936-1986, from Smith (2009; Demography)
Figure 1.3. Educational attainment at ages 25-29, across 1911-1985 birth cohorts

Note: Estimates from Snyder and Dillow 2013
Figure 1.4. Conceptual overview of the relationship between parental education, child health, and educational attainment.
Chapter 2: Change and Stability in the Maternal Education Gradient in Child Health: Evidence from 1965-2013 Birth Cohorts

Children born to socioeconomically advantaged mothers enjoy higher birth weight, better overall health status, and fewer health conditions than their counterparts from humbler origins (Brooks-Gunn and Duncan 1997; Case, Fertig, and Paxson 2005; Case, Lubotsky, and Paxson 2002; Currie 2009; Goodman 1999). A substantial fraction of research on socioeconomic inequalities in child health focuses on the health-promoting resources associated with mother’s educational attainment, finding that mothers who complete more schooling tend to have healthier children than mothers with less education. Such research generally assumes this relationship is time-invariant (e.g., Case, Fertig, and Paxson 2005; Fletcher and Wolfe 2013; Goodman 1999). Yet the strength of socioeconomic resources’ health protectiveness may have been modified as children born across the last several decades have grown up in transformed social and demographic contexts.

On one hand, women’s increased access to educational opportunities across the latter half of the twentieth century (Buchmann et al. 2008; Goldin 2006) has weakened the selectiveness of greater attainment and, therefore, the importance of schooling as a marker for the types of advantage that promote offspring wellbeing. Across cohorts, children with mothers at a given level of schooling might enjoy fewer health-promoting activities and behaviors than those born earlier did. Meanwhile, children born across the last century have faced lower acute health risks than those born earlier in the twentieth century due to secular improvements in public health.

2 Earlier versions of this chapter were presented at the 2015 Society for Research in Child Development Biennial Meeting in Philadelphia, PA and at the 2015 Population Association of America Annual Meeting in San Diego, CA.
(e.g., sanitation) and in medical technologies (Smith and Delaney 2012; Cutler and Miller 2005). Maternal advantage has become less important for accessing these health-promoting resources across cohorts. On the other hand, the most advantaged families have become engaged in a “reproduction project” alongside rising inequality (Mitnik, Cumberworth, and Grusky 2013). They are investing increasing amounts of time and money in their children across cohorts, widening absolute and relative gaps in resource allocation across families along the socioeconomic ladder.

Understanding the consequences of these countervailing patterns is of particular concern because early-life circumstances have a “long arm” across the life course (Hayward and Gorman 2004) and affect the life chances of the next generation. A key barometer of life chances, child health is an aspect of wellbeing in its own right and a determinant of later life outcomes (Haas 2006; Palloni 2006). Children born into disadvantaged beginnings are likely to remain there throughout their lives.

In light of mixed evidence described below, I use data from the 1982-2013 National Health Interview Surveys to investigate whether mother’s education continues to offer the same level of health protectiveness for children born between 1965 and 2013. Specifically, conflicting hypotheses and empirical evidence coupled leads me to ask: (1) Has the maternal education gradient in child health changed across 1965-2013 birth cohorts? (2) Has the direct path between maternal education and child health changed across cohorts? and (3) How have the relationships between mother’s education and parental investments and parental investments and child health changed across cohorts?
BACKGROUND

Socioeconomic gradient in child health

Children of socioeconomically advantaged parents tend to be healthier than those from less-advantaged families. This relationship holds both for summary measures, such as subjective health (Goodman 1995) and height (Cochrane and O'Hara 1982), as well as for specific health conditions. Socioeconomically advantaged children are less likely to be low birth-weight (Conley and Barrett 2000; Currie and Hyson 1999; Meara 2001) and less likely to suffer from a number of physical and mental health illnesses than are disadvantaged children (Case, Lubotsky, and Paxson 2002; Currie and Stabile 2003; MacLeod and Shanahan 1993, 1996).

Socioeconomically advantaged children’s health advantage exists from birth (Currie and Moretti 2003) and extends across childhood and adulthood (Case, Fertig, and Paxson 2005).

In this chapter, I focus on maternal education as a determinant of children’s health. Mothers, more than fathers, contribute to children’s early-life exposures, especially via their interactions with children. Mother-child interactions also vary by educational attainment. Better-educated mothers spend more time interacting with their children, spend more time on educational activities, and transmit more skills and norms to their offspring compared to their less-educated counterparts (Bourdieu 1977, 1986; DiMaggio 1982; Kalil, Ryan, and Corey 2012; Lareau 2002, 2003). They are also more likely to engage in health-promoting behaviors (Cutler and Lleras-Muney 2010; Cutler and Moretti 2003), have more money (Morris and Western 1999), and possess greater knowledge and psychological resources (Ross and Mirowsky 2003) than less-educated mothers. As a result, children of better-educated mothers are healthier than their less advantaged peers (Case, Fertig, and Paxson 205; Currie and Moretti 2005; Gakidou et al. 2010; Meara 2001; although see Desai and Alva 1998 for an exception).
The shape of the education gradient in child health

[Figure 2.1 about here]

Figure 2.1 depicts the basic bivariate relationship between maternal schooling and child health using data from the 1982-2013 National Health Interview Surveys (NHIS) calculated via locally weighted scatterplot smoothing. This approach allows the data to specify the shape of the mother’s education-child health relationship without imposing linear or polynomial constraints. Health is assessed by a subjective measure: a parent (usually a mother) rates her child’s health on a five-point scale ranging from “poor” (1) to “excellent” (5). Each of the four lines in the figure corresponds to children of different ages: 0-3 years, 4-8 years, 9-12 years, and 13-17 years.

Here we clearly see that children from socioeconomically privileged families enjoy better health than those from less-advantaged families. Importantly, the observed health advantage improves, fairly linearly, with increasing levels of maternal schooling. That is, a maternal education gradient in child health is clearly present in late-twentieth and early-twenty first century United States.

Figure 2.1 also illustrates some differences in the magnitude of the maternal education gradient across a child’s age. Older children face slightly stronger health protection from their mothers’ education compared to younger children. However, the magnitude of the maternal education gradient is fairly identical for children in the middle two ranges (4-8 years and 9-12 years). The convergence of the age lines on the right side of the graph also indicates that there are few age differences for children of the most-educated women in the sample.

Not a static process

The magnitude of the maternal education gradient in children’s subjective health may not be fixed across birth cohorts; the health protectiveness of mother’s education might have
changed due to shifts in women’s educational opportunities, children’s early-life contexts and exposures, and families’ ability to access health-promoting resources. But relatively few studies have considered trends in education gradients for children’s health, and those studies focus on changes in health gaps between groups rather than the potentially changing importance of education itself.

Such research finds mixed trends. Across time, the socioeconomic gap in birth weight has converged (Aizer and Currie 2014; Mathews and MacDorman 2007), and differences in self-assessed health have modestly narrowed between those living above and below the poverty line (Warren 2012). In contrast, Singh and Kogan (2007) find socioeconomic gradients in child mortality have increased between 1969 and 2000. To my knowledge, however, no work has examined cohort change in the importance of mother’s education for child health.

An examination of cohort trends in the changing effect of maternal education on child health can identify implications of macrosocial demographic, social, and policy trends for children’s future life chances. The unequal production of child health is one of the first steps in the reproduction of advantage across generations (Currie 2009; Haas 2006; Palloni 2006). Not only does maternal education shape a child’s health, but an individual’s health as a child also determines later life educational attainment. A weakened education gradient in child health across birth cohorts suggests that children’s early-life health may have become less important for reproducing advantage, perhaps as a result of twentieth-century social investments (e.g., in schooling and health). On the other hand, a strengthened gradient across cohorts suggests that socioeconomic contexts are durable determinants of poor health and that unchecked rising social inequality in the allocation of resources could be exacerbated by the growing importance of social resources for determining health.
Why expect change across cohorts?

A review of the resources linking higher maternal education and better child health offers a sense of how and why the gradient might have evolved over birth cohorts. Figure 2.2 summarizes the relationships between mother’s education, income, family structure, and child health.

Maternal education directly affects child health (path a) and indirectly affects child health through family income and through family composition and configurations associated with parent-child time (Currie 2009; Currie and Moretti 2003). That is, more-educated mothers tend to have greater incomes (path b) and more-advantageous family structures (e.g., two-parent households with fewer siblings) (path d) than do less-educated mothers (Blank 2011; Ramey and Ramey 2010; Sayer et al. 2004). Both income and family structure promote child health (paths c and e, respectively) (Case, Lubotsky, and Paxson 2010; Dunifon and Ziol-Guest 2014; Hsin 2012). Family structure also helps to determine family income (path f). I represent this path with a dashed line because its trends affect empirical estimates of other relationships but lie beyond the scope of my current analysis. Although there are other potential ways in which mother’s education affects child health (e.g., state-level variation in insurance access), I do not depict them in Figure 2.2, as they also lie beyond the scope of the present analysis.

Change in any of the labeled pathways or in any combination of them has the potential to affect the strength of the maternal education gradient in child health. Moreover, changes need not occur in the same direction; some paths may have strengthened across birth cohorts whereas others may have weakened due to various macrosocial influences. In the next section, I review theoretical and empirical evidence for why we might expect the magnitude of each pathway to
have strengthened or weakened across birth mid-twentieth century to early twenty-first century birth cohorts.

Rising tides?

Women’s educational opportunities rapidly expanded during the twentieth century, increasing female educational attainment (Buchmann et al. 2008; Goldin 2006). Whereas only the most economically advantaged, healthiest, and motivated women could graduate from high school or attend college previously, a wider range of women has become able to attain more schooling in recent decades. This expansion of educational opportunity means that having a mother with greater levels of schooling may no longer serve as a strong marker for children growing up in favorable contexts (e.g., having a mother with a particular set of knowledge or behaviors that can help buffer them from negative health events).

Selection explains part, but not all, of why children of more highly educated mothers enjoy better health. Prior research demonstrates that education captures both the effect of schooling itself as well as the effect of other maternal characteristics (e.g., her family background and health endowments) that propel her to attain more education and protect child wellbeing (Behrman and Wolfe 1987; Wolfe and Behrman 1987). Evidence from natural experiments (e.g., Doyle et al. 2005; McCrary and Royer 2006) shows that selection into schooling also contributes to the observed education gradient in child health. Factors that lead individuals to attain more schooling may also prompt them to make greater health investments (Fuchs 1982). However, other research from natural experiments indicates that that the positive effect of maternal education on health is mostly causal (Currie and Moretti 2003). (See Currie 2009 for a detailed review of causality.)
Insofar as selection-related behaviors and practices account for a portion of the overall maternal education gradient, mother’s education would have become less protective of offspring health over successive birth cohorts. Educational attainment would have served as a weaker proxy for behaviors that are protective of child health and wellbeing. Therefore, the direct path between mother’s education and child health (Path (a) in Figure 2.2) would have weakened and might explain a smaller fraction of the total effect of maternal schooling on health.

Secular improvements in the floor level of children’s wellbeing also may have weakened the education gradient in child health across cohorts. Public health efforts and medical advances, such as vaccinations and clean water, have improved child health throughout the twentieth century (Fogel 2004; Cutler and Miller 2005). Access to these interventions has reduced children’s exposure to infectious diseases as well as to particularly harsh and health-damaging environments. The introduction of food stamp programs and other nutrition-focused interventions beginning in the 1960s improved the health of socioeconomically disadvantaged children (Aizer and Currie 2014; Pérez-Escamilla et al. 2000). Therefore, mother’s education and its associated knowledge and practices may have become less important for protecting children from these health risks. These trends, like those in educational attainment, primarily suggest the “direct” path between mother’s education and offspring health weakened across cohorts.

Income and family structure trends: social inequality and a “reproduction project”

Against this backdrop of improved conditions that may have reduced the education gradient across cohorts, other changes may have increased the magnitude of the indirect paths through which mother’s schooling is hypothesized to protect offspring health (Currie 2009; Goodman 1999). As depicted in the conceptual diagram (Figure 2.2), income and family structures are two of these key pathways. In the following sections, I review evidence for cohort
change in each of these paths. Rising social inequality has likely left children of better-educated mothers increasingly exposed to greater family income and health-advantageous family structures across cohorts, while children of less-educated mothers have not enjoyed this increased exposure across cohorts. Meanwhile, advantaged parents’ “reproduction project” has likely increased the importance of these exposures for child health.

**Family income**

Growing disparities in income have potentially strong implications for the relationship between maternal education and child health, as one of the primary pathways through which their education protects offspring wellbeing is through educated mothers’ greater incomes than less-educated mothers (Currie 2009). Financial resources are prerequisites for accessing quality food, medical care, and neighborhoods (Currie 2009), each of which contributes to children’s mental and physical wellbeing (Bhattacharya et al. 2006; Currie and Gruber 1996; Earls and Carlson 2001; Leventhal and Brooks-Gunn 2002; Evans, Wolfe, and Adler 2012).

The indirect effect of maternal education attributable to more- and less-educated mothers’ differences in income might have strengthened across cohorts. More-educated mothers tend to be richer mothers (path (b)) and, over time, individuals have enjoyed greater economic returns to schooling (Card and Krueger 1992; Perna 2003). Moreover, this stronger link between education and income has potentially been accompanied by an increasing value of income for child health. The most advantaged mothers have not only gained income relative to their less advantaged counterparts, they also are using it more effectively across cohorts to promote their children’s wellbeing.

That is, the path between income and child health may have strengthened across birth cohorts due to parents’ differential child investment strategies amid rising social inequality.
Recent decades have witnessed a steepening “development gradient” (Kalil, Corey, and Ryan 2012). Socioeconomically advantaged parents have become increasingly engaged in a “reproduction project” (Mitnik, Cumberworth, and Grusky 2013) or “rug rat race” (Ramey and Ramey 2010) to ensure the transmission of advantage to their offspring. The most advantaged families have used their growing share of economic and noneconomic resources more effectively across time.

For example, Kornich and Furstenberg (2012) show that the most advantaged families increased the share of their income spent on services and activities believed to foster child development and potential future human, social, and cultural capital acquisition between 1970 and 2000. This change in behavior means that the effect of income on child health may have increased across cohorts. The possession of a particular amount of family income implies a larger amount of child-directed spending; children now receive a larger “dose” of their parents’ income than they had in earlier decades.

However, other prior research suggests that income may have become less important for protecting child health across cohorts. In examining whether public health insurance reduced child health disparities in the latter part of the twentieth century, Currie and colleagues (2008) find that the effect of income on children’s health actually dropped in the 2000-2005 period compared to 1986-1990 for 9-12 year olds and dropped in both 1996-1999 and 2000-2005 for 13-17 year olds. Although unable to account for the observed decrease empirically, they hypothesize that pre- and neo-natal improvements might have improved the health of the worst-off children across their childhoods. Thus, there is incomplete and conflicting evidence concerning the changing importance of income for child health across birth cohorts.
Family structure

Family structure also mediates the education gradient in child health (Currie and Moretti 2003). Over cohorts, the relationship between maternal education and family structure has likely strengthened alongside rising social inequality. Children born in more recent years are generally more likely to have single parents, older parents, fewer siblings, and working mothers (Carlson and England 2011) compared to those born decades earlier. This transformation was uneven: macrosocial trends in childbearing, family size, and household headship differ across the socioeconomic spectrum (Cherlin 2005; Goldin 2006; McLanahan and Percheski 2008; Ramey and Ramey 2010; Sandberg and Hofferth 2001, 2005). This unevenness has contributed to the concentration of the children of better-educated mothers in “favorable” family structures conducive to child health and the concentration of less-educated mothers in less favorable families. Therefore, maternal education has likely become more predictive of family structure across twentieth century birth cohorts.

An increased emphasis on a “reproduction project” among highly educated parents across birth cohorts also extends to non-financial investments in their children. One reason why certain family structures tend to produce healthier children is because of the type of parenting they permit, such as high quantity and high quality parent-child time (Sigle-Rushton and McLanahan 2002; Ziol-Guest and Dunifon 2014). For example, single parents and younger and older parents face more time demands than married, 25-35-year-old parents that constrain parent-child time, and larger families dilute per-child time; as a result, the children of more-educated mothers enjoy more parent-child time than the children of less-educated mothers do (Bianchi et al. 2004; Gauthier et al. 2004; Kalil, Ryan, and Corey 2012; Sayer, Bianchi, and Robinson 2004).
This disparity might have widened across birth cohorts. Sandberg and Hofferth (2001, 2005) find that children spent more hours per week with their parents in 1997 than in 1981, with larger gains in two-parents families with college-educated mothers than for single-parent families with less-educated mothers. Ramey and Ramey (2010) find that parents across all levels of education have increased the amount of time spent on child-focused caretaking starting in the 1990s, but college-educated parents have done so to a greater extent than less-educated parents. This difference in the amount of time, coupled with more-educated parents’ relatively greater attention focused on their child’s developmental needs, has led to a widened “developmental gradient” in recent decades (Kalil, Ryan, and Corey 2012).

The quality and quantity of parent-child interactions, in turn, influence child health. As noted above, family configurations determine parental resources and, therefore, parenting (McLanahan and Percheski 2008). Mothers’ with parenting styles that involve some combination of healthy behavior promotion and caregiving may improve child health compared to styles that involve lower quality parent-child interactions (Dunifon and Ziol-Guest 2014). Caregiving can foster beneficial health habits and allow mothers to observe children’s symptoms early in the course of an illness (Dunifon and Ziol-Guest 2014).

However, it is difficult to predict changes in health returns to family structure across birth cohorts (Figure 2.2, path (e)). The replacement of infectious diseases with chronic and psychological conditions as the primary causes of childhood illness (Delaney and Smith 2012) suggests offsetting forces exert their influence on the maternal education gradient in child health. Family structure may have become increasingly protective of child health across cohorts to the extent that preventative care and illness caretaking—both correlated with family structure (Case and Paxson 2001, 2002; Ziol-Guest and Dunifon 2014)—reduce the severity of such illnesses.
But many chronic diseases involve less acute symptoms than do infectious diseases. To the extent that family structure predicts time spent with children, more-educated mothers might better perceive low-severity symptoms than less-educated mothers and use this information to seek medical attention and diagnosis. In turn, considering a child’s symptoms and/or diagnosis may cause a mother to view her child’s health as worse than a mother who does not identify or recognize symptoms (King and Bearman 2009, 2011).

To summarize: Evidence presented above leads me to predict that mother’s knowledge, tastes, and preferences (the direct path) have become less important for child health across birth cohorts. However, I also hypothesize that each of the indirect paths has strengthened across birth cohorts: mother’s education has become more predictive of family income and family structure, and both income and family structure have become stronger predictors of child health. The countervalence of direct and indirect trends across cohorts, however, makes it difficult to predict trends in the total association between mother’s education and child health. To test these hypotheses and examine patterns in the total association, I analyze whether the importance of mother’s resources for child health has changed for children born at different points over the last several decades, paying attention to trends in each of the five pathways described above.

**DATA AND METHODS**

Data are from the 1982-2013 waves of the National Health Interview Survey (NHIS). The NHIS is an annual cross-sectional snapshot of the health of the United States population. The survey samples households and asks detailed questions about the health of all members of the household. A knowledgeable adult, generally a child’s parent, provides health and demographic information about household minors. Additional details about NHIS design and questionnaires can be found elsewhere (National Center for Health Statistics 2012). NHIS data used in the
present analyses were obtained via the Integrated Health Interview Series (IHIS), an aggregated and harmonized version of surveys. Assumptions about recoding to permit comparability across waves are reported on the IHIS website (www.ihis.us).

**Measures**

**Health.** My primary dependent variable is the child’s subjective health status. Parents report their child’s general health status on a five-point scale (1 = “poor,” …, 5 = “excellent”). Although imperfect, parental reports of subjective health status provide a more conservative assessment of health status than self- and teacher-reported measures, as parents tend to rate their child’s health lower than the child him/herself does (Johnson et al. 2010).

A subjective measure of child health offers two advantages. First, as a summary measure of wellbeing, it is likely less sensitive to changes in morbidity and diagnosis patterns than are specific disease/illness indicators. Subjective health captures both an underlying condition as well as the parent’s and/or child’s experience of health or illness. This property offers some stability in the measure despite the advent of new medical treatments over the course of the twentieth century. Second, subjective health is measured fairly consistently over the course of the study period despite a major NHIS redesign in 1997. Although the measure is available prior to the 1982 NHIS, response categories are on a four-point rather than five-point scale, rendering the measures incomparable.

**Mother’s education.** In most analyses, I include maternal education as a years-of-schooling measure. Prior to 1997, respondents reported their highest year of completed schooling. Beginning with the 1997 survey wave, the NHIS added categorical measures of an individual’s highest credential for schooling above 12 years. To make these measures comparable, I convert the categorical responses to a continuous one based on the category’s
midpoint. This approach produces estimates of years of schooling similar to those found in the Current Population Survey (CPS). The appendix contains additional detail about question wording and results from the NHIS-CPS comparison.

**Family income.** NHIS respondents report their family income categorically. I follow the precedent of other studies (e.g., Case, Lubotsky, and Paxson 2002; Currie, Decker, and Lin 2008) and convert income to a continuous measure. Specifically, I draw a group-specific mean from the Current Population Survey (CPS)\(^3\) that corresponds to the NHIS income category. For each year and NHIS income category, I calculate the mean family income for the CPS household head who matches the NHIS reference person’s education (less than high school, high school diploma, some college, and bachelor’s degree or higher), and sex (male, female). I convert this amount to the pooled decile. Alternative specifications (logged income and absolute income) yield substantively similar results unless noted otherwise below.

**Family structure.** Due to the type of information available in the NHIS, I create an index of family structure by summing indicator variables for each of the three family configurations (range: 0-3). Higher values on the index suggest that children are located within a more health-advantageous family structure.\(^4\) I measure father presence with a binary indicator of his presence (vs. absence) within the household\(^5\) and family size with a binary measure indicating whether a

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\(^3\) I use data from the Integrated Public Use Microdata Series Current Population Survey (IPUMS-CPS). These files have been partially harmonized by staff at the University of Minnesota Population Center. Assumptions concerning harmonization can be found on the IPUMS-CPS website (https://cps.ipums.org).

\(^4\) Sayer and colleagues (2004) note that prior empirical work provides mixed evidence concerning whether older parents have less time to spend with their children, more time, or the same amount of time. Due to this ambiguity, I re-estimate all models using only the other two indicators of family structure. Differences are fairly minor. For example, without maternal age, direct paths account for about 1 percent more of the total effect, and there is less variation in within-block indirect paths (the range of coefficients is about 5 percent smaller).

\(^5\) Fathers are determined to be absent if they are not NHIS respondents, if the child’s mother reports to be unmarried, and he is not present on the household roster. This measure was
child has no more than one sibling under 18 years of age. I estimate a mother’s age at her child’s birth by subtracting the child’s age at the time of interview from her age at interview. Maternal age does not affect child health in a linear manner; children of the youngest and oldest mothers face greater health penalties compared to those born to mothers aged 25-35 (Myrskylä and Fenelon 2012). As a result, I measure mother’s age at the child’s birth via an indicator variable for whether she is in this range associated with better child outcomes.

Additional covariates. In all models, I control for various demographic characteristics of a child, including his/her sex (male, female), race (white, black, Asian, other), ethnicity (Hispanic, non-Hispanic), region (south vs. other), age (indicators for each age), and mother’s work status (works, does not work).

The 1982-2013 NHIS includes 885,347 respondents aged 0 to 17 years. I exclude children who are not reported as the son or daughter of the household reference person or spouse, children who were not living with at least one of their parents (usually a grandparent), and children who are not members of the “primary family” within the household (n = 124,616). As noted by Case, Lubotsky, and Paxson (2002), these exclusion criteria help to dampen concerns about whether family resources are available to the respondent child. For similar reasons, I also exclude children who could not be matched to their mothers, who have parents who are minors (<18 years old) at the time of the survey, and do not have a mother present (n= 15,522). I also exclude 10,736 children from the 1982 and 2013 waves who fall outside the Lexis space partitions (described below).

A number of respondents are missing information on one or more key variables. The majority of missing data was for mother’s education (1.39 percent of the post-restriction sample) compared to the explicit measure of father absence included in surveys starting with the 1997 redesign; this question and my coding scheme produced nearly identical estimates of father absence.
and family income (17.33 percent). Results from logistic regression estimates indicate that missingness is not random: children with less-educated mothers, non-white children, and those from larger families have significantly higher odds of missing income measures than their counterparts. Alternate strategies to handle missing data, such as multiple imputation, offer the same substantive conclusions as analyses on the listwise deleted sample. Such exclusions leave a final sample size of 594,326 children born between 1965 and 2013. Table 2.1 describes the sample with respect to key social and demographic variables.

[Table 2.1 about here]

**Analytic strategy**

I use a two-step approach akin to a hierarchical model that allows me to examine both age and cohort. As noted by Lynch (2006), this approach offers a number of distinct advantages over other analytic strategies for examining change over cohorts. Most salient for the current analysis, this approach allows for flexibility in the parametric assumptions for age and cohort effects. Other approaches require *a priori* specifications of the shape of the cohort (and age) trend for the indirect paths between mother’s education and child health, mother’s education and income/family structure, and income/family structure and child health. As illustrated below, the employed approach allows an examination of patterns before introducing additional constraints and, therefore, reveals their patterns over cohorts.

Specifically, I divide the sample into two-year cohort by two-year age “blocks,” for a total of 144 blocks. For example, children aged 16-17 years born in 1967-1968 populate one block, whereas children aged 0-1 years born in 2009-2010 constitute another. This division of the

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6 Beginning with the 1990 survey wave, the NHIS provides imputed family incomes. I do not use these values because the imputation strategy is not consistent across years. However, preliminary robustness checks with this measure yield estimated trends similar to those presented in this paper.
lexis space leaves between one (two cohorts) and nine (eight cohorts) blocks per cohort, with an average of 6 blocks. Individuals born in 2007 and 2008 are observed for three blocks (when 0-1 years old, 2-3 years old, and 4-5 years old) but those born in 1981-1996 are observed for all age intervals. (Appendix Figure 2.A1 illustrates the division of the Lexis space.)

Within each cohort-age block, I use separately estimate the path model specified in Figure 2.2 linking mother’s education, family income, family structure, and child health.

Specifically, I estimate the following equations:

\[ H_{ib} = \beta_{0b} + \beta_{1b}MaEd_{ib} + \beta_{2b}Inc_{ib} + \beta_{3b}Fam_{ib} + \eta_kX \]  
(2.1)

\[ Inc_{ib} = \gamma_{0b} + \gamma_{1b}MaEd + \gamma_{2b}Fam + \tau_kX \]  
(2.2)

\[ Fam_{ib} = \alpha_{0b} + \alpha_{1b}MaEd + \pi_0X \]  
(2.3)

Where \( H \) is the subjective health of a child \( i \) in cohort-age block \( b \), \( MaEd \) is her mother’s education (in years), \( Inc \) is her family’s income decile, \( Fam \) is her 0-3 family composition index score, and \( X \) is a vector containing the control variables described above. These three equations provide estimates for each of the lettered paths in Figure 2.2: \( a = \beta_{1b}, b = \gamma_{1b}, c = \beta_{2b}, d = \alpha_{1b}, e = \beta_{3b} \).

These regressions yield 144 sets of coefficients particular to children of a given age born in a given year. I measure paths with ordinal outcomes via ordered logistic regression, and binary outcomes via logistic regression. Estimated coefficients depend on the degree of residual variation in models, which precludes a direct comparison of coefficients across logistic regression models (Allison 1999; Mood 2010). Thus, I re-estimate all paths via ordinary least squares (OLS) regression. Cohort trends estimated from OLS are substantively similar to those presented. These within-cohort-age block regressions are unweighted. As observed in Table 2.1,
the characteristics of the weighted and unweighted samples are fairly similar. Empirical results are robust to the use of survey weights.

From the estimated within-block coefficients obtained from these models, I calculate indirect pathways. Specifically, I compute:

(i) the indirect effect of mother’s education on subjective health through each of the indirect paths, which the product of the coefficients for each of the education-mediator and mediator-health paths:

\[ \text{IndInc}_b = \gamma_{1b} \beta_{2b} \]  
\[ \text{IndFam}_b = \alpha_{1b} \beta_{3b} \]

(ii) the total effect of mother’s education on health, which is the sum of the direct education-health path and the indirect paths:

\[ \text{Tot}_b = \beta_{1b} + \gamma_{1b} \beta_{2b} + \alpha_{1b} \beta_{3b} + \alpha_{1b} \gamma_{2b} \alpha_{1b} \]

and (iii) the share of the total association between mother’s education accounted for by the direct association, which is the direct association divided by the total association:

\[ \text{Ratio}_b = \beta_{1b} / \text{Tot}_b \]
Finally, I regress these coefficients on measures of birth cohort and age to test how these paths may have changed over birth cohorts. I include linear specifications of two-year cohorts (0= 1965-1966, …, 24=2011-2012) and two-year age ranges (0=0-1 years, 2=2-3 years, …, 16=16-17 years), each of which corresponds to the minimum birth year and age of children with that block. That is, I estimate:

$$\beta_{1b}^{Tot_b} = \delta_0 + \delta_1 A_b + \delta_2 A_b^2 + \delta_3 C_b + \delta_4 C_b^2 + \delta_5 C_b^3$$  \hspace{1cm} (2.8)

Where the left hand side of the equation represents each of the five paths described in Equations 2.1-2.3, the overall indirect paths for income and family structure, the total association between mother’s education and child health, and the ratio of the direct path to the total association. The primary coefficients of interest are $\delta_3$ and, where applicable, $\delta_4$ and $\delta_5$, which represent cohort trends in each of the associations of interest.

Although I include up to a cubic term in Equation 2.8, the five paths illustrated in Figure 2.2 might not all share the same age and cohort trajectories. I allow the specification of cohort and age to differ across paths. After estimating the model with all higher-order cohort terms, I estimate models in which I omit the cubic and quadratic and cubic terms, respectively. I keep higher order polynomials insofar as they improved model fit (as measured by substantial decrease in BIC) and are significant. The final path specifications are presented in the results section.

Each model is weighted by the number of children within each block. Although this second set of regressions does not take into account the uncertainty of the coefficients from the first model, this test is ultimately a conservative one as it reduces nearly six hundred thousand observations into 144 observations (see Lynch 2006).
I also estimate additional models (not shown) that take into account uncertainty at both the individual- and cohort-level but impose parametric constraints. First, I estimate a hierarchical model in which I let intercepts vary by age and cohort and the coefficient on mother’s education to vary by cohort. I also introduce cross-level interactions between cohort and each of the mediating variables. Second, I estimate a model where I introduce parametric constraints on age, period, and cohort (e.g., linear and quadratic age in three-year intervals, linear and quadratic cohort, and period indicator variables). Both of these additional approaches substantively similar estimates and are not presented.

RESULTS

Descriptive findings

Variation across age and cohort

Before turning to my three research questions concerning trends in the maternal education gradient in child health across birth cohorts, I first summarize results from 144 two-year-cohort-by-two-year-age blocks (Table 2.2). Although these descriptive statistics do not provide answers about the trajectory of the maternal education gradient across cohorts, they demonstrate that the strength of the gradient is not fixed across age and cohort and reveal that, on average, all cross-sectional relationships are in directions consistent with prior literature and/or my hypotheses.

[Table 2.2 about here]

The total effect (the sum of the direct and indirect paths) remains positive for all cohorts. On average, each year of mother’s schooling is associated with a .124 unit increase in subjective health (rated 1-5, with higher values indicating better health). The total effect varies across children at different ages (range: .079 to .184). That is, there is evidence of a maternal education
gradient in child health across all cohort-age blocks, but the magnitude of the gradient varies by age and cohort, highlighting that prior research’s assumption of a fixed education gradient is likely not a tenable one.

The magnitude and direction of the indirect paths is consistent with my hypotheses and with prior research. A one-year increase in mother’s schooling is associated with an increase of about one-third (.317) to over half (.515) a family income decile (mean: .398); in turn, an increase in a family’s income decile improves child health (about .115 units). Mothers who completed more schooling have more health-favorable family structures than mothers who attain less education, whereas family structure’s influence on child health varies across age and cohort. This variation around the block means does not reveal the direction of change, but it does indicate that “rising tides,” a “reproduction project” or other macrosocial patterns could plausibly have reshaped the magnitude of the four indirect paths and, therefore, the total importance of income and family structure for the education gradient.

**Standardization and alternative model specifications**

Results presented are unstandardized estimates from models that use a combination of ordered logistic, logistic, and OLS regression, depending on the measurement of the outcome variable. The second and third columns of Table 2.2 highlight the relative difference in magnitude between approaches that standardize the coefficients or use OLS regression to estimate all paths. The second column presents results that are standardized to allow comparisons of paths’ relative magnitudes, net of different measurement units. Free of these differences, the relative importance of the two indirect pathways becomes clear: income’s total direct path is about six times larger (.077/.013=5.9) than family structure’s total path but only two-thirds as large as the direct path (.077/.113 = .68). Therefore, a small relative change in the health
advantage due to mother’s skills and knowledge and/or her higher income would have a larger influence that a small relative change in the importance of family structure.

The last column reports the results from models that use ordinary least squares regression to estimate all direct and indirect paths. Estimates from these models are generally smaller, as expected. Prior research suggests smaller estimated socioeconomic gradients from logistic models than from OLS models (see Keppel et al. 2005 and Goesling 2005). Logistic approaches measure relative differences, whereas linear regression approaches measure absolute difference. Additional models estimated using OLS regression suggest similar cohort trends and are, therefore, not presented.

**Has the total association between mother’s education and child health changed?**

**Descriptive trends across cohorts**

[Figure 2.3 about here]

The above summary statistics highlight variation across children born at different years who are different ages, but do not give a sense of cohort trends. To get a better idea of the extent of variation across cohorts, Figure 2.3 depicts the mean within-block coefficient for each observed cohort. The left panel (A) plots the total association and direct association between education and health across cohorts. Both of these paths have substantially decreased in magnitude across birth cohorts, indicating a decline in the maternal education gradient in child health. Children born in more recent years face an appreciably smaller health advantage from their mothers’ education compared to those born decades earlier, with even larger estimated decreases in the importance of aspects of education associated with her skills and knowledge.

The center panel (Panel B) illustrates the overall economic path (the product of two indirect paths), the overall family structure path, and the overall indirect path (the sum of the
overall economic and family structure paths). Here, smaller changes across cohorts are observed. The overall economic path has decreased, albeit weakly, and the overall family structure path has increased over time; while the relative change is appreciable, the absolute increase is modest. Maternal education’s association with child health operating through educated mothers’ location within families with more income and health-favorable configurations (e.g., two-parent and smaller families, mothers aged 25-35 at the time of a child’s birth) has not changed substantially across children’s birth cohorts.

These overall indirect effects, however, obscure underlying heterogeneity. The final panel (Panel C) of Figure 2.3 presents the four indirect paths from which the total overall paths are calculated. Consistent with the broader stratification literature, the path from education to income has increased over cohorts: children with more-educated mothers born in the early twentieth century have more economic resources than those children born in the 1960s. However, a steady decline in the association between income and child health has offset this increase. While more-educated mothers have become richer, income has not continued to afford the same health protection for children. Similarly, the two paths related to family structure and configuration have evolved in countervailing directions. While mother’s education has become less predictive of time resources, these resources appear to have become more beneficial for child wellbeing.

Multivariate results

These descriptive trends include a combination of age and cohort effects, as not all cohorts are observed at all ages. There are likely strong age trends: parental socioeconomic status becomes more predictive of health as children get older (Case, Lubotsky, and Paxson 2002) but socioeconomic disparities narrow across childhood (Hurst 2010; Kalil, Corey, and Ryan 2012).
To take account of age differences, I regress the 144 coefficients obtained from the cohort-by-age blocks onto cohort and age (see Eq. 2.8). The models presented include linear age and quadratic age, as well as linear, squared, and/or cubic cohort. As noted earlier, I include higher order cohort polynomials insofar as they were statistically significant. I compared BIC scores across these models and retained those that appreciably improved model fit. Additional models with indicator variables for specific cohorts, decade wide cohorts, and age-by-cohort interactions failed to improve model fit (based on BIC values) and increase the amount of variance explained (based on R-squared values). I present the more parsimonious models that restrict cohort change to linear, quadratic, or cubic trends.

Table 2.3 presents the results from regressions of the block-specific paths on cohort and age. These regressions, weighted by block size, provide additional support for the trends described above. For aid with interpretability, I also plot the predicted cohort trends (with age set to zero years) for the paths specified in the conceptual model as well as calculated indirect and total associations calculated from these coefficients.

Results from these regressions suggest a marked decrease in the importance of maternal education for child wellbeing. The total association between mother’s education and child health has decreased about 1.3 percent every two birth years, net of age. However, a statistically significant quadratic term suggests that this decrease has begun to slow down starting with children born in the 1990s. Overall, these declines in the total association between mother’s education and child health translate to a 39.9 percent reduction in the education gradient for children born in 2013 compared to those born in 1965.
Has the direct path changed across cohorts?

Like the total education gradient in child health, the direct path between mother’s education and child health has weakened across 1965-2013 birth cohorts. Consistent with rising educational attainment and improving floor levels of child wellbeing, the health protection afforded by mother’s knowledge, skills, tastes, and preferences halved for children born in more recent years for children born in the beginning of this interval compared to those born in the most recent year. However, this increase did not occur uniformly across children born in during the observation period. The top panel of Figure 2.4 illustrates that a marked decline for most birth cohorts, with a reduction in the rate of decrease for children born in the last two decades.

The final row of Table 2.3 suggests that this reduction in the direct path has left it explaining a smaller share of the total association across cohorts. The ratio of the direct path to the total association has decreased by 62.9 percent. Across cohorts, educated mother’s control of economic resources and location within advantaged family configurations have become more important for understanding why their children are healthier than those born to less advantaged women.

Have indirect paths changed across cohorts?

Across birth cohorts, income’s and family structure’s mediating pathways have experienced weaker changes than the direct path and total association between mother’s education and child health. Results from Table 2.3 suggest that the indirect path due to income has weakly declined over cohorts, net of age, but only modestly. Although comparing the oldest (1965) and youngest (2013) cohorts suggests a one-third reduction in the indirect path, the trend has been relatively flat for children from the majority of cohorts examined: the indirect path was
about 15 percent smaller for those born between 1977 and 1999 than for the oldest cohorts, but fell only one-quarter of one percent between 1977 and 1999.

Similarly, maternal education’s indirect influence on health through family structure is fairly stable across cohorts. There is a statistically significant upward trajectory across cohort that translates into a 1.1 percent reduction for every two-year birth cohort. However, examining the magnitude of the coefficients and examining the trend in Panel A of Figure 2.4 suggests that there was no substantively meaningful cohort change the overall indirect path through family structure.

What might explain the relatively weak trend for the two indirect paths?

Turning to each of the four indirect paths, we observe countervailing and offsetting patterns that have contributed to aforementioned relative stability (Table 2.3 and Figure 2.4, Panel B). Consistent with prior findings on social stratification, more-educated mothers have enjoyed greater income in recent decades (Morris and Western 1999; Perna 2003; Western, Bloome, and Percheski 2008). However, these economic resources have decreased in their importance for child health across birth cohorts; the income gradient in child health is 45.4 percent smaller for children born in 2013 than those in 1965. However, this decrease has been uneven, with the substantial declines for the oldest and youngest cohorts and relatively stability for children born from 1980 to the mid-1990s.

A similar pattern of countervailing trends is observed for the two family-structure paths. Contrary to hypotheses, the relationship between education and family structure has weakened across cohorts. This decline was strongest across children born in the twentieth century and has begun to slow down during the last couple decades. Meanwhile, greater time resources have
become more beneficial to child health across cohorts. Over my period of observation, time
gradient in child health has increased, linearly, by nearly fifty percent.

**What drives trends in the education gradient?**

[Table 2.4 about here]

To what extent is the decrease total association between mother’s education and child
health attributable to change in each of association’s constituent pathways? Table 2.4 presents
additional analyses that help to answer this question. I regress the within-block total association
onto age (and age-squared), cohort (and cohort-squared), and within-block constituent paths.

Model 1 reprints estimates from Table 2.3, illustrating that the total maternal gradient in
child health decreases across birth cohorts. Linear and quadratic age and cohort trends explain
about half ($R^2 = .5226$) the variation across age-by-cohort blocks. In Model 2, I introduce the
direct path between mother’s education and child health to assess to what extent age and cohort
patterns in the total association are explained by the changing health importance of mother’s
knowledge, skills, and behaviors. This direct path is a significant predictor of the total
association and increases the total variation explained to over 90 percent ($R^2 = .9032$). The
introduction of the direct path also substantially reduces the estimated cohort trend. Although
each cohort term becomes statistically insignificant, linear and quadratic cohort patterns remain
jointly significant ($F^2_{138} = 8.87; p < .001$). Therefore, the direct path explains a substantial portion
of the overall decline.

Models 3 and 4 introduce both income and both family structure paths, respectively.
Neither of these models explains appreciably more of the variation in the total association across
cohorts nor reduces the cohort trend substantially. Therefore, cohort declines in magnitude of the
direct path between maternal education and child health explain most of the decrease in the total education gradients across birth cohorts.

**Standardized measure**

Results presented thus far are based on unstandardized coefficients from within cohort-by-age block estimates of the education gradient. These coefficients, unlike standardized ones, do not take into account distributional changes, such as increases in overall schooling and income levels, that have occurred across birth cohorts and age (Lynch 2006). Standardizing the direct path from mother’s education to health, for example, multiplies the unstandardized coefficient (reported earlier) by the standard deviation for years of schooling. Standardized coefficients can obscure the changing effect of years of schooling, but scaling parameter estimates by the distribution can shine some additional light on how the changing distribution of maternal educational attainment, family resources, and child health might affect cohort trends.

[Figure 2.4 about here]

Figure 2.4 presents select results from standardized models. In particular, I focus on the direct path between mother’s education as well as the income and family structure gradients in child health. Accounting for within cohort-by-age block variation, trends in the direct path between mother’s education and child health have followed the same basic decreasing pattern as earlier models. However, the slowdown in the rate of decline occurs earlier and is more marked than with the model that regressed unstandardized within-block coefficients on age and cohort. This finding suggests that changing education distributions have had modest effects on the direct importance of their maternal educational attainment (e.g., knowledge, tastes, and preferences) for children born in the mid-twentieth century, but might help to explain the declining direct path among children born in the latest decades.

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7 As I estimate Equation 2.1 with ordered logistic regression.
Trends in the association between family structure and child health reveal a steady increase in the importance of family time resources for child health across cohorts. Children born in more recent years have experienced greater health returns to their advantaged family structures (having a father present, having fewer siblings, and being born to a mother aged 25-35 years). Accounting for changing variation in family structure does not substantially affect the estimated trend across cohorts.

However, large differences in the changing importance of economic resources for child health emerge after accounting for changing income variance. In earlier models, income’s health effects were observed to have weakened across cohorts, whereas this models suggests that rising variation in income (Western, Percheski, and Bloome 2008) actually has contributed to increasing health effects of income across cohorts. To interrogate this finding, I also re-estimate unstandardized results using an alternative measure of income, namely cohort-specific decile (not shown). This new measure compares children’s economic resources to children who were born in the same year. As with standardized results, this additional analysis also suggests that income has not become a weaker predictor of child health for children born in more recent decades.

Taken together, results from these two models suggest that the absolute importance of income for child health has decreased across cohorts, but the importance of one’s relative income has increased. Thus, there is evidence for both the “rising tides” and “reproduction project” phenomena described earlier for the association between income and child health based on overall decile results and standardized and cohort-specific results, respectively.

Across all models (standardized and unstandardized), age and cohort trends explain a moderate portion of the observed variation in the size of education gradient across blocks. The
R-squared values presented in the final column of the table suggest that such trends explain between 19.6 and 88.5 percent of the variation in within-block coefficients. Additional sensitivity analyses (not presented) with larger three-cohort-by-three-age blocks and with categorical measures of cohort, age, and interactions between them produced similarly small R-squared values. Therefore, although there is evidence of cohort trends, net of age patterns, residual contextual factors also influence variation in the education gradient in child health across cohort-by-age blocks.

**DISCUSSION AND CONCLUSION**

The life course perspective emphasizes that individuals experience their lives within a set of social, cultural, and historical contexts shared by others in their birth cohort (Gee, Pavalko, and Long 2007; Elder, Johnson and Crosnoe 2003; Ryder 1965). The primary aim of this study is to interrogate whether such contextual changes have reshaped the importance of maternal educational attainment for the health of children. Evidence suggests that mother’s education is about forty percent as important for the health of children born in the 2010s than it had been for those born in the mid-1960s. Improvements in the direct association between mother’s education and child health can account for most of this observed decline.

**Change: Declining direct path**

What, then, explains the decline in the direct path between mother’s education and child health? Net of income and family structure, this path largely captures better-educated mother’s increased skills, knowledge, tastes/preferences, and behaviors (including health behaviors). The “rising tides” phenomena described earlier—secular trends in women’s educational attainment and general health improvements—remain a leading candidate for explaining the estimated fifty percent decrease across 1965-2013 birth cohorts. Public health, sanitation, and nutrition
programs have reduced children’s risks of facing particularly deadly or debilitating exposures (Fogel 2004; Cutler and Miller 2005). Whereas mother’s human capital attainment had previously helped advantaged children to avoid the riskiest exposures, the reduction in overall exposure lessened the importance of maternal resources for learning about and accessing critical health resources.

Another “rising tide,” namely increased educational attainment for women (Buchmann et al. 2008; Goldin 2006), implies that schooling has become a weaker marker of advantage associated with unobserved characteristics that promote educational attainment and good child health. For example, a mother’s own poor health, which may be transmitted intergenerationally (Ahlberg 1999), may have become a smaller barrier to continuing schooling across cohorts. Educational attainment may also have become a weaker indicator of a child’s grandparents’ advantage across time; previous’ generations’ advantages might extend across generations and affect a child’s life chances (Mare 2010).

Consistent with these accounts, additional analyses (not presented) replacing the continuous measure of maternal schooling with a marker for a college degree indicate greater declines in the direct path between education and offspring wellbeing than the presented results do. Additionally, both educational selectivity-related explanations suggest that the causal component of the education gradient in child health (see Currie 2009) should have weakened across birth cohorts. NHIS data do not permit me to explore this possibility in the present analyses.

Unobserved components of the direct path

However, trends in the direct path between mother’s education and child health might obscure underlying variability with respect to unobserved paths that also explain why more-
educated mothers have healthier children than do less-educated mothers. Education provides
mothers with increased cognitive and psychological skills (Herd 2010; Ross and Mirowsky 2003;
Ross and Wu 1995) and an improved ability to acquire, process, and act on information
(Lindeboom, Lena-Nozal, and van der Kaauw 2006). In turn, these benefits might shift her
tastes and preferences and affect the household production of health (Grossman 1972, 2003). For
example, more-educated mothers have greater knowledge about and access to resources critical
for their children’s long-term wellbeing than less-educated mothers have (Augustine and
Crosnoe 2013; Coleman 1998).

Likewise, education might also protect child health through health-promoting behaviors
and practices (Cutler and Lleras-Muney 2010). Compared to women with lower educational
attainments, better-educated women are less likely to smoke and drink (Pampel, Krueger, and
Denney 2010), two behaviors that negatively affect child health (Currie and Moretti 2003).
Across cohorts, smoking rates have also decreased across cohorts (Pampel 2005), reducing
children’s exposure to tobacco inside and outside their homes. The extent to which each of these
unobserved pathways might account for the observed decrease in the direct path was not
explored in this analysis due to data limitations and is left to future studies.

Slowing trends

Despite the decrease in the education gradient, trends in the total association and the
direct association appear to be slowing. Descriptive plots of the raw within-cohort-age-block
coefficients (Figure 2.4) and the quadratic cohort trend (Table 2.3) each suggest that some of the
decline in the direct path between mother’s education and child health may have slowed for
younger cohorts. This decline is consistent with empirical and theoretical insights from related
literature and with my explanations. Public health and medical advances have reduced infectious
disease risk to historically low levels, leaving the remainder of the illness burden as chronic and congenital conditions (Delaney and Smith 2012). Such conditions are likely to be less sensitive to large-scale interventions than infectious disease and, therefore, differences in family resources may become increasingly important for prevention and/or treatment across cohorts.

Additionally, the fundamental cause theory contends that mother’s education qua socioeconomic advantage is a durable determinant of health (Link and Phelan 1995). This theory posits that even as the proximate causes and risk factors for illness change, socioeconomic status remains a determinant for wellbeing. While gradients may have narrowed with respect to some diseases, they have persisted or grown for conditions that are becoming more common across time and cohorts (Meich et al. 2011; Phelan and Link 2010). Therefore, with the rise of new illness and risk patterns, the slowdown in the importance of mother’s education for child health might actually reverse and lead to a strengthened gradient.

**Stability: Overall indirect paths and underlying heterogeneity**

The story for indirect paths is less straightforward than the story for the direct link between maternal education and child health, and analyses reported above did not support all of my initial hypotheses. As depicted in Figure 2.4, both of the overall indirect paths experienced relatively little change across birth cohorts. However, this overall stability obscures underlying countervailing patterns: mother’s education has become a stronger determinant of economic resources, which is less consequential for children’s health (in most models), and mother’s education has become less associated with family structure, which has become more consequential for children’s health.
Family structure

I find that the path from mother’s education to family structure weakened across birth cohorts. At first blush, this decrease is inconsistent with evidence suggesting that children are facing “diverging destinies” such that socioeconomically advantaged children have been increasingly concentrated in advantaged family structures (McLanahan 2004). However, upon closer inspection, some compositional factors have disproportionately benefited children of less-educated mothers. For example, less-educated mothers have experienced greater declines fertility rates than do more-educated mothers, such that disadvantaged mothers’ rates began to approach the already-reduced levels of more-educated women (McLanahan 2004). Moreover, cohort growth in maternal age among the most-educated mothers has increasingly left a greater number of their children born when they are older than 35 years, the upper-end of the range associated with the healthiest offspring (Myrskylä and Fenelon 2012) and the most parent-child time (Sayer et al. 2004).

However, family structure has become more closely related to children’s wellbeing across cohorts. This finding is consistent with a “reproduction project” across cohorts in which educated parents are investing additional family time resources in childrearing and are increasingly more time with their children compared to less-educated parents (e.g. Ramey and Ramey 2010; Sayer et al. 2004). Indeed, we might expect stronger increases for younger children as nearly all the increase in parent-child time is attributable to differences among parents with very young children (Aguiar and Hurst 2009; Hurst 2010). For children 0-5 years old, college-educated mothers spend 9.4 more hours a week on child care than those with less education, but that difference narrows to one hour for 13-17 years old children (Hurst 2010). Consistent with
this “reproduction project” account, additional exploratory analyses suggest slightly stronger cohort trends in the family structure for the youngest children than for older children.

At the same time, these family time resources have become more strongly associated with child health across birth cohorts. Unfortunately, my data did not let me adjudicate between multiple possibilities. On one hand, parents might have become better at using these resources to promote child wellbeing and/or reduce health risks across cohorts. That is, parents—not just the most advantaged—might have engaged in a “rug rat race” to maximize their children’s life chances. On the other hand, the specific conditions from which children suffer (i.e. increasingly chronic and psychological conditions) may have become more responsive to family structure than conditions from which children had suffered previously in part due to the “reproduction project” but also due to increased access to the latest treatments due to insurance and economic resources.  

**Offsetting income paths**

Mother’s education operates indirectly through family income to protect child health. As with family time resources, the two halves of this indirect path changed in offsetting ways across cohorts. While education has become a stronger predictor of income (Path (b) in Figure 2.2), the health effects of income have substantially weakened (Path (c)). The net effect was to decrease

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8 In a separate set of analyses (not shown), I also re-estimate all models separately for boys and girls. Compared to boys, girls experience (marginally-significant) greater increases in the importance of family structure for child health across birth cohorts. These findings are consistent with an account that views family structure as influencing parental investments: a historical preference for male offspring has decreased alongside an increase in egalitarian orientations in recent years. Parents are now largely indifferent to offspring sex (Pollard and Morgan 2002), and only minor differences in spending patterns for male children only households still persist (Lundberg and Rose 2004).

Additionally, compared to boys, girls experience greater declines in the direct association between mother’s education and child health, in the income gradient in child health, and in the total education gradient in child health.
importance of income as an indirect pathway in the education gradient in child health. Thus, although growing inequality has led to the concentration of economic advantage, the decreasing consequence of this disadvantage has served as a counterweight for some of these gains. The latter pathway not only has slowed the increased disadvantage, it has offset it.

In general, there is mixed evidence for increasing parental engagement in a “reproduction project” or “rug rat race” affecting child health with respect to income. As noted in the introduction, advantaged parents’ more effective allocation of economic resources would imply a stronger income gradient.

However, the declining association between income and child health is consistent with a “rising tides” account. Expanded nutrition and state-sponsored insurance programs, such the State Children’s Health Insurance Program (SCHIP) introduced in 1996, have reduced disparities in access to medical care, although some evidence suggests that Medicaid expansion had only weak effects on babies’ outcomes (Howell 2001) and evidence for SCHIP’s impact on child health status is mixed (Howell and Kenney 2012) or modest (Currie et al. 2008). However, these modest declines coupled with reduced costs and increased access to basic medical interventions has reduced the importance of economic resources for obtaining preventative services and treatment.

**Relative versus absolute income**

Countervalance was also present for standardized models in which my results revealed that family income has become more important for child health across cohorts. In those models, however, modest trends in better-educated mother’s family income (not shown) suppressed the relatively large increase in relative income’s health protectiveness. The net effect was one of a
modest change across cohorts, though an increasing one unlike in models where the cohort-by-age-specific gradients were not scaled by the amount of variation in the measure.

Divergence in these two measures is consistent with both the “rising tides” and “reproduction project” phenomena. As noted earlier, health insurance and nutrition policies coupled with improvements in medical technologies, which increased accessed pre- and neonatal care (Aizer and Currie 2014; Currie et al. 2008), could decrease the importance of income for accessing effective medical care relative to those born earlier. At the same time, the “reproduction project” could mean that—relative to other families with children born at the same year—those at the top of the distribution have become increasingly more effective and efficient at spending their money to promote child wellbeing, offsetting the policy increase.

Children’s life chances

The decline in the education gradient highlights the uncertainty about what growing social and economic inequality mean for children’s life chances. Across a number of childhood outcomes, there is evidence of rising socioeconomic inequalities, such as students’ test scores (Reardon 2011). However, for other outcomes that matter for children’s life chances, increased social and economic inequality has not lead to increased inequality. For example, Duncan and colleagues (2012) failed to find evidence that family income is a stronger predictor of completed schooling despite rising social inequality and test score inequality. A number of other studies find either no changes over time/cohorts or only modest ones for processes that produce individuals’ advantage or disadvantage, such as social mobility (e.g., Biblarz and Raftery 1999) and other intergenerational processes (e.g., Musick and Mare 2004). For example, Musick and Mare (2006) found stability in trends in the transmission of family structure and poverty across generations.
This analysis, however, is not without its limitations. First, the relationships that I discuss are not necessarily causal. I cannot truly isolate the extent to which economic and family time paths may have caused the observed change in child health inequalities. Moreover, changing educational attainment and family formation patterns may have both be determined by other external forces that are not expressly examined in my analyses. Second, the need to use consistent measures across birth cohorts limits the richness of variables examined. I measure health via a single-item subjective measure. The extent to which these changes extend to specific illnesses or types of illness is unknown. Nor can I examine the contribution of a child’s birth weight, an aspect of health that shapes subsequent child health (Grossman 1972; Palloni 2006; Palloni et al. 2009) and that has improved over time (Aizer and Currie 2014).

Third, the present analyses use cross-sectional data. Currie and Stabile (2003) note that investigations using cross-sectional data to estimate socioeconomic gradients in child health may obscure the processes underlying the gradient. Two distinct scenarios could produce the observed results. Children of less-educated mothers may take longer to recover from a given health insult, allowing illnesses to compound and accumulate as children age. On the other hand, disadvantaged children also may experience more health insults compared to their peers. By only looking at health in snapshot for any particular birth cohort, these two possibilities cannot be teased apart. However, there is some evidence that the latter scenario is not as strong in the United States as in Canada, the setting for Currie and Stabile’s research (Condliffe and Link 2008).

Understanding whether the education gradient in child health has changed in magnitude falls at a critical juncture for highlighting implications of macrosocial inequality trends for children’s life chances and the durability of the mechanisms that link parental socioeconomic
circumstance to child health. Growth in inequality is of concern to sociologists and
demographers because it may have negative consequences for children’s wellbeing and life
chances. This study finds that while inequality has grown in other areas of children’s lives, it
appears to have narrowed in this one important domain. However, despite becoming weaker, the
education gradient in child health persists. More advantaged children—namely, those of better-
educated mothers—remain healthier children than children from humbler origins.
Figure 2.1. Cross-sectional maternal gradient in child health (1982-2013 National Health Interview Surveys)

Notes: Figure estimated via locally-weighted scatterplot smoothing (lowess).
Figure 2.2. Conceptual overview of the relationship between mother’s education, economic resources, family structure, and child health
Table 2.1. Percents or means (and standard deviations) for key social and demographic characteristics, NHIS sample

<table>
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<tr>
<th></th>
<th>Unweighted Mean (s.d) / %</th>
<th>Weighted Mean (s.e) / %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mother’s education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years</td>
<td>12.85 (2.79)</td>
<td>13.15 (.015)</td>
</tr>
<tr>
<td>HS or more (%)</td>
<td>82.38</td>
<td>85.57</td>
</tr>
<tr>
<td>BA or more (%)</td>
<td>20.58</td>
<td>23.54</td>
</tr>
<tr>
<td><strong>Health (1-5)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Excellent” or “very good” (%)</td>
<td>81.06</td>
<td>82.71</td>
</tr>
<tr>
<td>Family income (1999 USD)</td>
<td>50060 (38509)</td>
<td>54159 (216.98)</td>
</tr>
<tr>
<td>Mother employed (%)</td>
<td>58.77</td>
<td>60.07</td>
</tr>
<tr>
<td>Number siblings (#)</td>
<td>1.46 (1.22)</td>
<td>1.04 (.002)</td>
</tr>
<tr>
<td>Father absent (%)</td>
<td>21.12</td>
<td>19.83</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>8.41 (5.10)</td>
<td>8.40 (.011)</td>
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<tr>
<td>Female (%)</td>
<td>48.91</td>
<td>48.92 (.011)</td>
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<tr>
<td>South (%)</td>
<td>33.87</td>
<td>34.52</td>
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<tr>
<td>Race (%)</td>
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<td></td>
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<tr>
<td>Black</td>
<td>15.62</td>
<td>13.67</td>
</tr>
<tr>
<td>Asian</td>
<td>3.22</td>
<td>3.23</td>
</tr>
<tr>
<td>Other</td>
<td>3.52</td>
<td>2.81</td>
</tr>
<tr>
<td>Hispanic ethnicity (%)</td>
<td>20.34</td>
<td>15.14</td>
</tr>
</tbody>
</table>

**Data:** 1982-2013 National Health Interview Surveys (NHIS)
Table 2.2. Regression coefficients from path models relating mother’s education, income, family structure, and child health for two-cohort by two-age blocks (n=144)

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Mean (s.d.)</th>
<th>Range</th>
<th>Standardized Mean (s.d.)</th>
<th>Range</th>
<th>OLS Unstandardized Mean (s.d.)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td></td>
<td>Indirect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education → health</td>
<td>0.074 (.020)</td>
<td>[.029, .131]</td>
<td>0.113 (.025)</td>
<td>[.049, .194]</td>
<td>0.031 (.009)</td>
<td>[.011, .057]</td>
</tr>
<tr>
<td>Education → income</td>
<td>0.398 (.041)</td>
<td>[.317, .515]</td>
<td>0.419 (.045)</td>
<td>[.323, .531]</td>
<td>0.398 (.041)</td>
<td>[.317, .515]</td>
</tr>
<tr>
<td>Education → family&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.038 (.011)</td>
<td>[.018, .066]</td>
<td>0.176 (.037)</td>
<td>[.105, .260]</td>
<td>0.038 (.011)</td>
<td>[.018, .066]</td>
</tr>
<tr>
<td>Income → health</td>
<td>0.115 (.020)</td>
<td>[.047, .161]</td>
<td>0.185 (.031)</td>
<td>[.091, .249]</td>
<td>0.048 (.010)</td>
<td>[.018, .073]</td>
</tr>
<tr>
<td>Family → health&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.023 (.072)</td>
<td>[-.105, .231]</td>
<td>0.024 (.027)</td>
<td>[-.026, .116]</td>
<td>0.014 (.031)</td>
<td>[-.046, .114]</td>
</tr>
<tr>
<td>Total indirect income&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.045 (.007)</td>
<td>[.021, .067]</td>
<td>0.077 (.011)</td>
<td>[.044, .118]</td>
<td>0.019 (.003)</td>
<td>[.008, .028]</td>
</tr>
<tr>
<td>Total direct family&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.005 (.003)</td>
<td>[-.005, .009]</td>
<td>0.008 (.003)</td>
<td>[.004, .016]</td>
<td>0.001 (.001)</td>
<td>[-.002, .005]</td>
</tr>
<tr>
<td>Overall indirect family&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.005 (.002)</td>
<td>[-.0001, .011]</td>
<td>0.013 (.003)</td>
<td>[.006, .022]</td>
<td>0.002 (.001)</td>
<td>[.001, .005]</td>
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<tr>
<td>Total (direct + indirect)</td>
<td>0.124 (.019)</td>
<td>[.079, .184]</td>
<td>0.052 (.009)</td>
<td>[.030, .080]</td>
<td>0.344 (.047)</td>
<td>[.222, .477]</td>
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<tr>
<td>Ratio of direct/total</td>
<td>0.591 (.078)</td>
<td>[.353, .758]</td>
<td>0.586 (.081)</td>
<td>[.369, .756]</td>
<td>0.589 (.080)</td>
<td>[.338, .772]</td>
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<tr>
<td>Within-block N</td>
<td>4123 (850)</td>
<td>[2704, 5797]</td>
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<sup>†</sup> p ≤ .1, * p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: 1982-2013 National Health Interview Surveys (NHIS)

<sup>a</sup> 0-3 index measure of mother’s age at birth, father’s presence, and number of siblings

<sup>b</sup> Product of the indirect paths between mother’s education and income and between income and child health

<sup>c</sup> Product of the indirect paths between mother’s education and family structure and between family structure and child health

<sup>d</sup> Sum of the previous line and the product of the indirect paths of family structure mediated by family income
Figure 2.3: Total, direct, and indirect paths across birth cohorts from two-cohort-by-two-age blocks (n=144)

Data: 1982-2013 National Health Interview Surveys (NHIS)
Table 2.3. Change in associations between mother’s education, income, family structure and child health across age and cohort for two-year period-cohort blocks, unstandardized

<table>
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<tr>
<th>Direct</th>
<th>Cohort</th>
<th>Cohort²</th>
<th>Cohort³</th>
<th>Age</th>
<th>Age²</th>
<th>Intercept</th>
<th>R²</th>
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<td>(.001)†</td>
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<td>(.0006)***</td>
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<tr>
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<tr>
<td>Education → familyᵃ</td>
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<td>.00001</td>
<td>--</td>
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<td>.7637</td>
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<td>Total indirect incomeᵇ</td>
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<tr>
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<tr>
<td>Ratio of direct/total</td>
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</table>

† p ≤ .1  * p ≤ .05, ** p ≤ .01, *** p ≤ .001
N= 144 two-cohort-by-two-age blocks
ᵃ 0-3 index measure of mother’s age at birth, father’s presence, and number of siblings
ᵇ Product of the indirect paths between mother’s education and income and between income and child health
ᶜ Product of the indirect paths between mother’s education and family structure and between family structure and child health
ᵈ Sum of the previous line and the product of the indirect paths of family structure mediated by family income
Figure 2.4. Predicted cohort trends in the maternal gradient in child health, 1965-2013

A. Total, indirect, and total indirect paths

B. Economic and family structure paths

Data: 1982-2013 National Health Interview Surveys (NHIS)
N= 144 two-cohort-by-two-age blocks
All predictions for a child age birth (age and age-squared set to 0).
Figure 2.5. Paths between mother’s education, income, family structure, and child health from standardized coefficients.

Data: 1982-2013 National Health Interview Surveys (NHIS)
N= 144 two-cohort-by-two-age blocks
## Table 2.4. Regression models of total association between mother’s education and component paths for two-year cohort-age blocks

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<td>Education → family$^a$</td>
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* $p \leq .1$, ** $p \leq .05$, *** $p \leq .01$, **** $p \leq .001$

Data: 1982-2013 National Health Interview Surveys (NHIS)
N= 144 two-cohort-by-two-age blocks
APPENDIX

Figure 2.A1. Division of Lexis space

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Where 64=1964,...,100=2000,...,112=2012

Cohort
Construction of education variable

As noted in the text of chapter, the NHIS underwent a major redesign in 1997. Prior to that year, individuals (in this case, mothers) were asked to report the total years of schooling completed; subsequently, they were asked to report their highest degree. This revision lead to an increase in the years of schooling completed that is a product of an increase in the number of respondents reporting an increase of more than 12 years of schooling as well as a decrease in the number reporting exactly 12 years of schooling. To see how these revisions may affect my estimate of trends, I plot years of schooling across survey waves and compare (weighted) NHIS estimates to (weighted) CPS estimates of trends. Vertical lines correspond to survey revisions in 1992 (CPS) and 1997 (NHIS). Based on the way I construct my NHIS sample, I expect NHIS estimates to be slightly lower than CPS estimates due to differences in my unit of analysis: the NHIS sample contains 1 observation per child whereas the CPS contains one observation by mother. Due to higher fertility among women with lower levels of education, such women should be disproportionately represented in the NHIS sample compared to the CPS sample.

Together, these trends indicate that years of education (panel (a)), less than HS (panel (b)), HS but less than BA (panel (3)), and BA+ (panel (g)) provide fairly stable trends over time. Therefore, I use these parameterizations in the presented analyses.
Table 2.A1. Survey for education question, NHIS

<table>
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<tr>
<th>Years</th>
<th>Survey text</th>
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| 1982-1996     | What is the HIGHEST level of school you have completed or the highest degree you have received? Please tell me the number from the card.  
00 Never attended/kindergarten only  
01-11. 1st grade-11th grade  
12 12th grade, no diploma  
13 GED or equivalent  
14 High School Graduate  
15 Some college, no degree  
16 Associate degree: occupational, technical, or vocational program  
17 Associate degree: academic program  
18 Bachelor's degree (Example: BA, AB, BS, BBA)  
19 Master's degree (Example: MA, MS, MEng, MEd, MBA)  
20 Professional School degree (Example: MD, DDS, DVM, JD)  
21 Doctoral degree (Example: PhD, EdD)  
96 Child under 5 years old  
97 Refused  
99 Don't know                                                                 |
| 1997-2012     | **EDUCATION OF INDIVIDUAL - COMPLETED YEARS**  
00. Never attended; kindergarten only  
01-12. Grades 1-12  
College:  
13. 1 year  
14. 2 years  
15. 3 years  
16. 4 years  
17. 5 years  
18. 6 years or more  
19. Unknown  
Blank. Under 5 years of age |
Figure 2.A2. Comparison of education trends: National Health Interview Survey (NHIS) versus Current Population Survey (CPS)

(a) Years of schooling

(b) Less than high school

(c) High school
(d) Some college

[Figure 2.A2, cont’d]

(e) High school or some college

(f) Postsecondary
(g) BA+

[Figure 2.A2, cont'd]
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<th>Child’s health</th>
<th>Mother’s education</th>
<th>Family income</th>
<th>Father present</th>
<th>Two BA+ parents</th>
<th>Number of siblings</th>
<th>Mother’s employ.</th>
<th>Mother’s age at birth</th>
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<td>-0.103</td>
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<td>0.2712 [0.2492]</td>
<td>-0.1011</td>
<td>0.0348 [0.0245]</td>
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Notes: Spearman rank coefficients presented, but Pearson coefficient matrix similar to above. Values in brackets indicate point biserial correlation coefficient. Child health is measured on a five-point scale: 5= “excellent,” … 1= “poor.” Family income measured in 1999 USD (in thousands).
**Figure 2.A3.** Correlation matrix of dependent and key independent variables (unweighted), 4-8 year olds, 1977-1991 vs. 1992-2004 birth cohorts

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<th>Father present</th>
<th>Two BA+ parents</th>
<th>Number of siblings</th>
<th>Mother’s employ.</th>
<th>Mother’s age at birth</th>
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<td>Two BA+ parents</td>
<td>0.1315</td>
<td>0.5525</td>
<td>0.397</td>
<td>0.1797</td>
<td></td>
<td>0.2317</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Number of siblings</td>
<td>-0.0358</td>
<td>-0.1439</td>
<td>-0.1026</td>
<td>0.0296</td>
<td>-0.0319</td>
<td></td>
<td>-0.0176</td>
<td>---</td>
</tr>
<tr>
<td>Mother’s employ.</td>
<td>0.0574</td>
<td>0.1972</td>
<td>0.2106</td>
<td>0.0391</td>
<td>0.0294</td>
<td>-0.204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s age at birth</td>
<td>0.0772</td>
<td>0.3379</td>
<td>0.3627</td>
<td>0.1449</td>
<td>0.2799</td>
<td>0.0143</td>
<td>0.0734</td>
<td></td>
</tr>
</tbody>
</table>


Child health is measured on a five-point scale: 5=“excellent,”...1=“poor”
Family income measured in 1999 USD (in thousands)
Chapter 3: The Maternal Education Gradient in Specific Childhood Conditions

The previous chapter examined trends in the maternal education gradient in health for children born between 1965 and 2013. Analyses across this wide range of cohorts required assessing health via a single-item subjective measure. Yet cross-sectional and cohort patterns might differ for indicators of specific health conditions. For reasons described below, children of more-educated mothers might be more likely to have health conditions than their less-advantaged counterparts. Moreover, a different set of macrosocial patterns might propel cohort trends for education gradients in specific conditions (e.g., expanded health care access) than propel cohort trends for education gradients in subjective health. Using information from the 1997-2013 National Health Interview Survey (NHIS) Sample Child files, I ask: What is the association between mother’s education and children’s specific health conditions? I then extend this analysis to consider cohort variation, asking: Does the strength of the maternal education gradient in childhood health conditions vary across 1979-2013 birth cohorts?

I focus on the influence of mother’s education on children’s reported health conditions. Though parental reports do not perfectly capture children’s actual disease status, they constitute an important population health metric. Descriptions of the health of the American population, policy decisions concerning child health, and assessments about whether the nation is making progress towards reducing health inequalities each rely on self- or parent-reported measures of symptoms or physician diagnosis (e.g., Centers for Disease Control 2012; Department of Health and Human Services 2010).9

9 Moreover, most research using secondary data examines diagnosed conditions. Although a handful of studies involve physician examinations or collect biomarkers (e.g., the National
Importantly, there is a crucial tension in the measurement of health via reported conditions. Reported health conditions are paradoxically markers of both health disadvantage and health advantage. The presence of a parent-reported health condition means that a child has displaying negative health symptoms that affect his quality of life and ability to interact with others around him. However, parental reports of symptoms (and/or the diagnosis of a disease) also generally mean that a child has received attention from her parents and/or received medical treatment. To the extent that mothers are picking up on “true” symptoms and not “over-diagnosing” benign symptoms, detection and treatment can buffer against severe symptoms and potentially reduce poor health’s consequences for the child’s life chances.

BACKGROUND

A growing body of research documents socioeconomic gradients in child health. This literature focuses on the effect of each percent increase in family income or on the effect of each year of maternal schooling on children’s health, not just the effect of falling above or below a particular threshold (e.g., the federal poverty line or college degree status). Such research into socioeconomic gradients generally finds that each unit increase in family socioeconomic advantage is associated with an improvement in child health. Children of mothers with one additional year of attained education have better subjective health status, taller stature, lower chances of obesity, and higher birth weight than children of mothers with just one less year of schooling (e.g., Currie and Moretti 2005; Gakidou et al. 2010; Nazarov and Rendall 2011; Meara 2001).

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Health and Nutrition Examination Survey, Add Health), these studies have limited measures of family socioeconomic context and/or have “objective” measures that correspond to a limited set of health outcomes.
However, most research on the education gradient in child health in the United States focuses on summary measures of health; it is unknown whether there is also a maternal education gradient in children’s likelihood of having a parent- or physician-identified health condition. Education gradients in summary health measures (such as birth weight and subjective health) and income gradients in diagnosed health conditions (such as asthma, diabetes, and epilepsy) support the maxim that “more education means better health.” However, as I describe below, more-educated mothers might be better able to recognize and report health symptoms than less-educated mothers can. This difference between more- and less-educated mothers could suppress or even invert this standard relationship of more education meaning better health.

An understanding of mother’s contributions to children’s health conditions sheds light on early-life dynamics. Mothers, more than fathers, are often the primary caretakers for their children. They are responsible for many aspects of childcare, including education-related activities and illness prevention and treatment (Case and Paxson 2001; Craig and Mullan 2010). But these behaviors vary by maternal educational attainment; maternal education predicts the quantity and quality of parenting behaviors (Guryan, Hurst, and Kearney 2008; Leibowitz 1974; Lareau 2003; Nazarov and Rendall 2011). For example, mothers with higher levels of education more frequently engage in parent-child interactions that promote children’s cognitive development, health, and overall wellbeing than do mothers with less education. Educated mothers are also more likely than less-educated mothers to take their children to visit health professionals (Case and Paxson 2001). Investigating the relationship between maternal education and children’s health conditions, therefore, offers insight into early-life processes and population health.
What is the relationship between mother’s education and children’s health conditions?

According to the human capital perspective within social epidemiology, each year of educational attainment carries additional knowledge, cognitive and non-cognitive skills, and psychological resources that buffer against stress and negative health events (see Ross and Mirowsky 2003; Ross and Wu 1995). It is likely that these resources, behaviors, and preferences carry forward to the ways in which mothers engage with their children’s health. Mothers can use psychological resources and health knowledge to prevent illness, recognize early symptoms, and navigate health systems to promote their children’s health.

Children of more-educated mothers also tend to live in families with greater income and family structures conducive to child wellbeing (e.g., two-parent families, fewer siblings) than children of mothers who have attained less education. Income and these family structures are associated with favorable child health (Currie 2009; McLanahan and Percheski 2008; Ziol-Guest and Dunifon 2014). Children of educated mothers are more likely to have health insurance coverage than those from humbler origins, partly because of better-educated mothers’ greater income and greater considerations of long-term investments (Cutler and Lleras-Muney 2006). Children of mothers who completed more schooling are more likely to have seen a doctor and/or a dentist within the last year and to have a usual source of medical care compared to children of mothers who attained less education (Case and Paxson 2001).

Even when accessing care, more-educated mothers differ from less-educated mothers. Ethnographic accounts suggest that mothers of higher socioeconomic status and their children tend to be more assertive and proactive in encounters with medical personnel than are mothers of

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10 Some research suggests that this relationship might be causal (see Currie 2009 for a detailed review of the literature for child health), whereas other research suggests that education and health preferences are jointly determined by other existing factors (Fuchs 1982).
low socioeconomic status and their children (Lareau 2003). Thus maternal education shapes many health-relevant aspects of the child’s environment.

[Figure 3.1 about here]

What, then, do these differences across levels of maternal education imply about the direction of the education gradient for specific health conditions? Figure 3.1 depicts a simplified model of how mother’s education might be linked to children’s reported health conditions. On one hand, we might expect the maternal education gradient in child health conditions to look similar to the maternal education gradient in subjective health: the share of children with a condition might decrease with increasing maternal educational attainment. Maternal knowledge and skills, income, and family structure can all reduce a child’s likelihood of developing a health condition. Access to preventative care afforded by health insurance coverage can also reduce a child’s chances of experiencing a negative health event.

On the other hand, we might expect the maternal education gradient in child health conditions to be the opposite of the maternal gradient in subjective child health: the share of children with a condition might increase with increasing levels of maternal educational attainment. Estimates of children’s health conditions come from parental reports of either observed health symptoms (e.g., diarrhea) or from physician diagnoses (e.g., asthma). As I describe below, maternal behaviors and practices associated with higher educational attainment suggest that better-educated mothers’ children might be more likely to have a reported health condition than children of less-educated mothers, regardless of true physiological differences between the groups. Under this hypothesis, reporting differences rather than differences in the
underlying “objective” risk of a health event would drive the maternal education gradient in health conditions.\footnote{Clearly, reported diagnoses and actual physiological phenomena are not the same thing. As I note in this chapter’s introduction, however, estimates of the distribution of health across American children often treat the two as interchangeable, mainly because of data limitations.}

Specifically, two maternal characteristics mean that children of mothers with more education may be more likely to be reported as having a health condition than are children of mothers with less schooling. First, increasing levels of education are associated with greater knowledge, psychological resources, and conscientiousness about health (Ross and Mirowsky 2003). These differences in knowledge and skills mean that more-educated mothers might be better able to identify low-severity or subtle symptoms in their children than are less-educated mothers.

Second, not only are more-educated mothers more able to recognize symptoms, but they are better positioned to do so than less-educated mothers. College-educated mothers spend more time in child-engaged activities compared to less-educated women (Guryan, Hurst, and Kearney 2008; Leibowitz 1974; Sayer et al. 2004), allowing them to monitor their child’s wellbeing more closely. Some conditions might be identifiable only after a pattern emerges over time, such as an allergic reaction that occurs every time a child eats a certain food (as discussed below). Thus higher-quality parent-child interactions might offer advantaged mothers more opportunities than less-educated mothers to recognize minor symptoms and identify a condition, and then to take their children to a medical professional if necessary (King and Bearman 2011).

Together, these differences between more- and less-educated women in terms of knowledge and behavior generate two competing hypotheses. First, I expect that children of more-educated mothers will be more likely to have a health condition than children of less-educated mothers. Because more-educated mothers have greater health-relevant knowledge and
parent-child time than less-educated mothers, more-educated mothers might be more likely to detect health conditions than their less advantaged counterparts. Second, children of highly educated mothers have more economic and non-economic resources than do children of less-educated mothers, and those resources protect their health. Greater income and family structures that are more conducive to child health (e.g., two-parent households, smaller families) mean that children born to more-educated mothers will have fewer health conditions than children born in families with lower income and less-optimal family structures. As single-parent families and larger families are constrained in the time available to for each child (Downey 1995; Gauthier et al. 2004), then taking into account family structure on top of maternal education should reveal smaller decreases in the gradient across birth cohorts.

Thus different features associated with increased maternal education are likely to have countervailing effects on child health conditions. According to the first prediction, highly educated mothers also are more likely to identify and report a health condition, such that children of more-educated mothers will have more health conditions. But according to my second prediction, children of more-educated mothers will have fewer health conditions.

Although these hypotheses are, in some senses, competing hypotheses, we might find evidence for both of them. For example, at a certain level of schooling, the importance of parental knowledge and time for identifying and reporting symptoms might plateau. Knowledge about conditions might not monotonically increase with each year of maternal schooling; after a certain level (e.g., college), education might not offer any additional resources that affect perceptions of child health. If this plateauing occurs, then we might observe a non-linear gradient in which increasing levels of maternal schooling above a certain point decrease children’s likelihood of having a reported condition among children of the most educated women. Such a
decrease could be attributable to more-educated mothers’ greater income and propensity to live in family configurations conducive to child health that reduce the “objective” probability of actually experiencing a health event.

Variation in the maternal education gradient across conditions

My discussion thus far has focused on the broad association between mother’s education and children’s reported health condition. However, conditions vary in their causes and consequences (see Jackson 2010 and Warren et al. 2012) in ways that suggest that the magnitude and direction of the maternal education gradient in health conditions might differ across specific health conditions. Importantly, as I argue below, these differences can also provide some purchase in distinguishing the contribution of some of the maternal characteristics and behaviors (e.g., health care knowledge, knowledge related to symptom recognition) to the connection between mother’s education and children’s reported conditions.

To tease apart the relative contributions of parental knowledge and time, I conduct separate analyses for specific conditions, grouping them on the basis of the degree to which they require health knowledge and prolonged parent-child interaction to identify. The first of these three groupings includes conditions that physicians diagnose (e.g., autism, asthma). In reporting these conditions, parents are often asked some variation of “Has your child ever been diagnosed with the following condition(s)…” By definition, receiving a diagnosis means that child has seen a physician and either the child or his parent (usually his mother) has described the child’s symptoms to the physician. Mothers must, therefore, recognize symptoms, access medical care, and engage with a physician. I hypothesize that more-educated mothers will be more likely to identify and report these conditions than less-educated mothers because of their greater knowledge relative to that of less-educated mothers. Therefore, as described above, I expect that
children with more-educated mothers will be more likely to have one of these health conditions than children of less-educated mothers.

The remaining two categories are conditions that are defined by their symptoms and are not necessarily identified by a physician or other health professional. Readily observable and identifiable conditions constitute the second category. Mothers (or even teachers) can immediately observe and identify the symptoms of these conditions (e.g., diarrhea, ear infections, and stutter/stammer). The skills produced by increased education are unlikely to matter for detecting these conditions, and so I hypothesize that children of mothers with more education may be less likely to have a health condition than children of mothers with less schooling. Alternatively, mother’s education level may be unrelated to children’s chances of having one of these conditions (i.e., a “flat” gradient), as many of these conditions are difficult to prevent (e.g., ear infections, stomach bugs picked up from classmates). Mother’s education would influence neither the incidence of the health condition nor mothers’ recognition of symptoms.

The third broad category includes allergies, which are less observable conditions that require parents to observe children over extended periods of time. Recognizing that a child sneezes every spring (i.e., has a pollen allergy) or complains of stomach pains only after a particular subset of foods (i.e., has a food allergy) requires viewing a child’s health trajectory over some extended amount of time and requires knowledge on the part of parents to isolate and identify the issue. That is, repeated parental involvement is necessary in order to discern the allergic pattern, even if the symptoms are fairly noticeable. Although diagnosis is not necessary, parents may also take their children to an allergist to identify the health condition. Thus the skills produced by increased education are very likely to matter for detecting these conditions, and so I
hypothesize that children of more-educated mothers will be more likely to have these conditions than their peers born to less-educated mothers.

**Has the association between mother’s education and children’s health conditions changed across 1979-2013 birth cohorts?**

As with the maternal education gradient in children’s subjective health, the maternal education gradient in children’s health conditions may have changed in magnitude across birth cohorts. In particular, three macrosocial patterns that have changed across cohorts—increasing educational attainment, increasing access to health care and medical knowledge, and increasing disparities in parent-child time—might have influenced the association between maternal education and children’s health symptoms. The first two macrosocial changes have improved the floor level of child wellbeing across the twentieth and early twenty-first centuries, but the third has lead to increasingly dissimilar and unequal family contexts across birth cohorts.

**Increasing educational attainment**

One of the most visible improvements in overall wellbeing has been a dramatic increase in women’s educational attainment during the latter part of the twentieth century. Across cohorts, mothers have become more educated largely due to an expansion of two- and four-year colleges that started in the 1960s (Snyder and Dillow 2013) and disproportionately benefited women (Mare 1997). This expansion means that educational attainment may have become a weaker marker for maternal advantage across birth cohorts (Hout 2012). This pattern means that the gradient between maternal education and child health might have weakened across cohorts because each year of maternal schooling (at the high school level and above) is now a weaker marker for knowledge and cognitive skill than it was for mothers born in early cohorts.
Another potential consequence of educational expansion is that lower educational attainment has become a stronger marker for disadvantage for mothers at the bottom of the education distribution. In other words, in more recent cohorts, not having much education is more distinctive than having a great deal of education. Women who still attain relatively few years of education were not able to take advantage of new educational opportunities because of their limited socioeconomic resources, poor health endowments, and/or other disadvantages. All of these factors might, in turn, contribute to their children’s increased chances of experiencing a negative health event. Across cohorts, the children of mothers with low educational attainments would have become more likely to experience a health condition. Assuming that, as hypothesized, the share of children with a condition increases with increasing maternal schooling cross-sectionally, then increasing disadvantage at the bottom of the education distribution would also weaken the maternal education gradient in health conditions across cohorts.

**Increasing access to medical care and health knowledge**

Moreover, the twentieth century also witnessed increased diffusion of health information and knowledge (e.g., via the internet). These improvements suggest that the importance of mother’s formal education for obtaining health-relevant information has diminished across cohorts. Whereas health-related knowledge tended to be available primarily to those with formal education among individuals born in the early- to mid-twentieth century, health-related knowledge is now more widely available. Socioeconomically advantaged mothers might have seen their hold on health-related knowledge decrease as a result of this increased access to medical knowledge, suggesting that the maternal education gradient in health has attenuated across birth cohorts.
Health insurance expansions might have also benefited children in ways that contribute to declining education gradients for health conditions. For example, pregnant women, infants, and young children became eligible for Medicaid coverage in 1984; in 1990, eligibility expanded for older children and for families making up to 133 percent of the federal poverty line (Currie 2008). Additional expansions occurred during the 1990s (starting with programs targeted toward older children) and included the introduction of the State Child Health Insurance Program (SCHIP) in 1996. Each of these expansions has reduced the cost of children’s access to care and allowed less advantaged children to access preventative care that was once only available to the children of highly educated mothers.

Admittedly, increased access to medical care and increased access to health knowledge each suggest a weakened gradient in the maternal education gradient in child health, but for different reasons. If children of better-educated mothers are more likely to have a condition than are the children of less-educated mothers, then disseminating knowledge widely would attenuate the maternal education gradient in health conditions across cohorts. Less-educated mothers might have become better able to recognize and report a health condition across cohorts. If children of more-educated mothers are less likely to have a condition than are the children of less-educated mothers, then increased availability of preventative care might attenuate the maternal education gradient in health conditions across cohorts. Across the latter part of the twentieth century, less-educated mothers might have become better able to prevent the occurrence of health events in the first place.

Increasing disparities in parent-child time

However, not all macrosocial patterns suggest a narrowing maternal education gradient in children’s health conditions. Although both college-educated and less-educated mothers have
spent more time with their children since the 1980s, rising social inequality has been accompanied by increased disparities in parental time investments in children between these two groups (Ramey and Ramey 2010; Sandberg and Hofferth 2001, 2005; Sayer et al. 2004). In 1985, college-educated mothers spent about 1.8 more hours per week engaged in childcare than less-educated mothers; by 2003, this disparity had grown to 6.7 hours (Hurst 2010). These patterns mean that more-educated parents might have become even better positioned to recognize children’s low-severity symptoms across birth cohorts, thereby widening the education gradient.

Evidence from diagnosis trends supports this possibility. King and Bearman (2009, 2011) find that increased diagnosis of the least severe cases of autism among richer children may account for the rapidly increasing prevalence of autism. Children from socioeconomically advantaged families are more likely to be diagnosed with low-severity cases of autism than their peers from humbler origins, but there are no disparities among severe cases. This finding is consistent with the suggestion that differences in parent-child interactions between advantaged and disadvantaged families have increased over cohorts. In turn, this evidence points to a stable or increasing maternal education gradient in specific child conditions across late-twentieth-century and early-twenty-first-century cohorts.

Variation in cohort trends across specific health conditions

Cohort patterns might also vary across specific health conditions. I expect variation to largely occur across the three categories that I described earlier (diagnoses, readily observable conditions, and allergies). Health insurance expansion, for example, would have weakened maternal education gradients in children’s diagnoses (which involve visiting a doctor) more than maternal education gradients in readily identifiable conditions (which may not). That is, easily recognized conditions, such as frequent diarrhea, are also unlikely to be affected by changing
educational attainment or increased parent-child time. As a result, across cohorts, children at a given level of maternal education would likely face the same likelihood of having a reported case of these readily identifiable conditions.

Cohort trends in the association between maternal education and conditions that do not require physician diagnosis but that do require some parental knowledge and repeated exposure to identify (e.g., allergies) are difficult to predict. On one hand, increasing educational attainment across cohorts would have reduced knowledge differences between more- and less-educated women who hold at least a high school diploma, reducing educational differences in the reporting of conditions. Educational attainment is hypothesized to have become a weaker marker for unobserved knowledge and skill.

On the other hand, as noted above, high school non-completion may now be a stronger marker for unobserved disadvantage in health or skill. Women who have been unable to complete high school despite increased opportunities are likely particularly disadvantaged. Across cohorts, I expect such health- and socioeconomically-disadvantaged women to constitute a larger share of high school non-completers. Furthermore, cohort increases in the amount of time spent with child disproportionately benefited the children of the most-educated mothers and would have strengthened the maternal education gradient in health conditions. Across cohorts, the most advantaged mothers would have become increasingly better positioned than less-educated mothers to detect children’s symptoms. Given these countervailing forces, I am agnostic about the direction of cohort trends in the maternal education gradient for conditions like allergies that require knowledge and repeated exposure to identify.

Implicit in this discussion has been the notion that examining specific indicators of child health can help disentangle the relative contributions to cohort trends in the maternal education
gradient of the macrosocial patterns that have changed across cohorts (increasing educational attainment, increasing access to health care and medical knowledge, and increasing disparities in parent-child time). Assuming that I find evidence of cohort trends in the strength of the maternal education gradient, variation in cohort trends across each of the three categories of conditions help to identify candidate explanations. If the association between mother’s education and children’s diagnoses has decreased, then expanded access to care is a likely driving force behind cohort trends. However, as parents also need to identify the symptoms in order to solicit a diagnosis, other factors may also play a role. If the association between mother’s education and readily observable conditions has decreased, then underlying health burdens have likely decreased across cohorts. Finally, if the association between mother’s education and allergies has decreased, then changes in mother’s knowledge due to increased educational expansion or the diffusion of knowledge are likely explanations.

**Current study**

Gaps in our understanding of the shape of the maternal education gradient in children’s health diagnoses lead me to ask three broad questions. First, to what extent is maternal education associated with children’s reported health conditions? Second, is there variation in the maternal education gradient across the specific conditions that children experience? Third, do these patterns change across cohorts?

As noted above, I hypothesize that increasing levels of maternal schooling are associated with increasing reports of children’s health conditions. However, children of highly educated mothers have more health-protective economic and non-economic resources than children of less-educated mothers that might contribute to a reversal of the direction of the gradient among the most-educated mothers. That is, above a certain level of maternal educational attainment, the
children of more-educated mothers might be less likely to have a health condition than the children of less-advantaged mothers. As noted earlier, these hypotheses assume that reporting differences rather than differences in children’s “objective” chances of experiencing a health event drive maternal education gradients in health conditions. Insofar as this assumption is correct, this maternal education gradient is expected only for conditions that require a physician diagnosis or that do not have immediately recognizable symptoms (e.g., allergies).

However, I expect these maternal education gradients to have weakened across late-twentieth-century and early-twenty-first-century birth cohorts because of rising educational attainment and increased access to health care and knowledge. Changing family contexts, especially disproportionate increases in parent-child time for the most educated parents, might offset some cohort declines for children with the most highly educated mothers. Yet cohort trends in the maternal education gradient might vary across specific health conditions because of the relative importance of expanded education and health knowledge.

DATA AND METHODS

Analyses use data from the Child Sample files of the 1997-2013 waves of the National Health Interview Survey (NHIS). The NHIS is an annual snapshot of the health of the non-institutionalized American population. Each year, the NHIS selects households (via a multi-stage probability design) and collects information about the health and demographics of all household members. Data are obtained from the University of Minnesota’s Integrated Health Interview Series (www.ihis.us). In the Sample Child files, a knowledgeable adult (generally a parent) was asked to report detailed information about health conditions for a randomly selected child from the household roster.
I restrict analyses to children for whom I can identify maternal and family characteristics. I exclude all children who are not the sons or daughters of the household reference person and/or spouse, children who are not living with either parent, and children who are not members of the primary family within the household. Missing data and item non-response are handled via listwise deletion, but results are robust to multiple imputation. The appendix contains a description of the sample’s characteristics.

Measures

Health conditions. Table 3.1 describes the eleven health conditions included in my analyses. These conditions span the range of health phenomena from which children suffer and are all family reported. There is substantial variation in prevalence across conditions: about 0.6 percent of children have an autism diagnosis (the least common condition) and about 13.2 percent have asthma (the most common condition). About 40.1 percent of children have at least one identified health problem. I examine the maternal education gradients in any condition as well as in eleven specific conditions.

[Table 3.1 about here]

Maternal education. As I focus on education gradients in child health, I measure a mother’s education by her years of completed schooling. Respondents report their educational attainment with the highest grade completed for 12 or fewer years and a categorical measure of their highest credential for schooling above 12 years. I convert the categorical measure to a continuous one by assigning the value of the midpoint of the interval. Although this measure is imperfect, it produces estimates of years of schooling similar to those found in the Current Population Survey (CPS). Additional details about this measure can be found in the previous chapter’s appendix.
Family resources. I measure family income by a family’s income decile. To calculate this value, I first convert the categorical NHIS measure to the category’s race-and-education specific mean from the CPS. That is, for each NHIS income bracket in each survey year, I calculate the mean family income for CPS household heads whose education and race match the NHIS family’s household and whose income falls within the income bracket. I then adjust this dollar amount to 1999 dollars using the Consumer Price Index (CPI) before calculating a family’s decile rank.

I examine family structure through three separate measures. I measure whether a child’s father is present via a binary indicator (1=present, 0 = not). I also include a measure of a mother’s age at the child’s birth. As noted in the previous chapter, there is evidence that children of mothers who were aged 25-35 at the time of birth are healthier than children born to teenage or older mothers (e.g., Myrskylä and Fenelon 2012). To account for this non-linearity, I include separate indicators for whether a mother was aged < 25 years or > 35 years at the time of birth (reference: mothers aged 25-35 years). I also include a linear measure of a child’s number of siblings (0 siblings,…,6 siblings). Finally, I capture whether a child has health insurance with a binary indicator of coverage (has insurance, does not).

Covariates. All models control for child’s age (indicator for year), sex (male, female), race (white, black, or other), ethnicity (Hispanic, non-Hispanic), region (south, other), and maternal employment status (employed, not).

Analytic strategy

To assess whether a cross-sectional maternal education gradient in children’s health conditions exists, I first plot the bivariate association between maternal education and children’s health conditions. At each level of maternal schooling, I examine the percent of children with at

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12 Parameterization determined by comparing Bayesian Information Criterion (BIC) values.
least one condition. I repeat this graphical exploration for each of the eleven health conditions. These descriptive analyses allow me to examine maternal education gradients without making strong assumptions about its shape (e.g., whether the maternal educational gradient is linear or non-linear).

These graphs offer a sense of the general relationship between the maternal education and children’s health conditions, but they do not account for differences in children’s characteristics and in family resources across levels of maternal education that also shape children’s health. To account for such differences, I turn to a multivariate framework and a series of nested models. I begin by regressing health conditions on maternal schooling and basic covariates (described above). I then sequentially add measures of family income, family structure, and access to health care. As the NHIS measures illness status as a binary outcome (has a condition, does not), I estimate all models via logistic regression. There are some concerns about the comparability of coefficients across logistic models (Allison 1999; Mood 2010), but additional analyses (not shown) in which I estimated linear probability models (via ordinary least squares regression) produced similar patterns across nested models.

To examine variation in the maternal education gradient across specific health conditions, I estimate the same series of regressions on each health condition separately. In line with other research that uses NHIS Sample Child files (e.g., Mehta et al. 2013), I use all data available for each health condition, even if they are missing data on other diagnoses. For example, a child whose asthma diagnosis status is unknown might still be included in autism estimates if his parent provided diagnosis information for that condition. Therefore, sample sizes vary across health outcomes and are listed in the final column of Table 3.1.
Cohort trends

After assessing the cross-sectional maternal education gradient in health condition, I turn to considerations of variation in the magnitude of the gradient across 1979-2013 birth cohorts. To examine cohort trends in the association between mother’s education and children’s health conditions, I estimate a logistic age-period-cohort model with period omitted (see Lynch 2003). Specifically, I estimate:

\[
\text{logit}(H) = \beta_0 + \beta_1 C + \beta_2 E + \beta_3 C E + \beta_4 A + \beta_5 A^2 + \beta_6 A E + \sum_{p=7}^{6} X_p \beta_p + \sum_{j=13}^{j} X \beta_j + e
\]

Where \( H \) is an indicator of having any health condition listed in Table 3.1 (in initial models) or specific health condition (in later models), \( C \) is a linear measure of cohort in one-year intervals (e.g., \( 0=1979, 1=1980, \ldots \)), \( A \) is a measure of age in two-year intervals, and \( E \) is mother’s education (in years). I allow the effect of mother’s education to vary by cohort and age. Although I assume that the gradient is fixed across periods, I control for a series of five-year period indicators to capture secular changes in health.\(^{13}\) The coefficient on the interaction between cohort and education captures whether the association between mother’s education and children’s odds of having a condition have increased or decreased across 1979-2013 birth cohorts.

Additional models allow for non-linear variation in age patterns across cohorts (via an interaction between age-squared and cohort) and/or for differences in the location of the age gradient in education across cohort (via a three-way interaction between age, cohort, and mother’s education). As the patterns themselves are not of theoretical interest and did not alter

\(^{13}\) Such assumptions about the shape of age, period, and cohort patterns allow me to separately identify the three.
substantive estimates of the main coefficients of interest, I omit them from the presented analyses and present a more-parsimonious model.\footnote{I also try several alternative approaches. Measuring age and cohort each with two-, three-, and five-year intervals does not affect any substantive findings. Replacing the continuous cohort measure with indicator variables reveals only minor non-linearities in cohort trends and fails to substantially affect model fit. As my analyses are mainly concerned with the direction of the change in the education gradient, I present the more-parsimonious models that constrain change in the gradient to a linear one. I also estimate cross-classified random effect models with random intercepts for age and a random slope on mother’s education. This specification treats being a certain age and being born in a certain year as a particular context that shapes how children experience their mother’s educational attainment. These models produce similar estimates to the ones offered below and, therefore, are not presented.}

RESULTS

What is the relationship between mother’s education and children’s health conditions?

Overall gradient

Is there an education gradient in children’s health conditions? To get a sense of the shape of the relationship, I begin by plotting the bivariate relationship between mother’s education and the percentage of children with any health condition (Figure 3.2). Table 3.1 lists the conditions that constitute this summary measure.

[Figure 3.2 about here]

Figure 3.2 illustrates the existence of a clear education gradient in child health. However, unlike the education gradient in subjective health and the income gradient in specific health conditions (e.g., asthma, diabetes), each year of maternal schooling is associated with an increased share of children with at least one health condition. For example, 33.2 percent of children of mothers who attained 8 years of education have at least one condition, compared to 39.6 percent of children with mothers who attained 12 years of education. But this gradient levels off and reverses for children with the most educated mothers. Each year of schooling among the most educated mothers is associated with a decreasing percentage of children with a
health condition. Specifically, children of mothers with 14 years of schooling have the highest percent of diagnoses (44.4 percent), but smaller shares of children of mothers with 16 years of schooling (38.8 percent) and 20 years of schooling (36.6 percent) have at least one health condition.

[Table 3.2 about here]

Moving from suggestive descriptive patterns to a multivariate framework, I estimate a series of nested logistic regressions (Table 3.2) to account for demographic differences across levels of education and to account for more-educated mothers’ advantages in terms of income, family, and health insurance that might contribute to observed patterns. I include the square of maternal education in all models based on the shape of the gradient in Figure 3.2.¹⁵

Multivariate results confirm the basic pattern depicted in Figure 3.2. In the first model, I adjust for differences in children’s sex, race, region, and age. Estimates suggest that each year of maternal education is associated with 14.9 percent higher odds of having at least one condition ($e^{1.149} = 1.149$), but this increase declines for the most advantaged mothers ($e^{-0.05} = .995$).

[Figure 3.3 about here]

To illustrate what this education gradient means substantively across levels of maternal educational attainment, the solid line in Figure 3.3 depicts the predicted probabilities calculated from the presented log-odds coefficients. (All other covariates are set to their means.) This figure closely mirrors Figure 3.2. Among children of mothers with less than 14 years of schooling (some college), each year of schooling is associated with an increase in the probability of having

¹⁵ I also estimate alternative models with indicators for levels of maternal education (< 12 years, 12 years, 12-15 years, 16+ years) and estimate spline regression models with a knot at 14 years of schooling (based on the inflection point in Figure 3.2). These additional estimates suggest the same basic patterns as the models presented here. I present the quadratic specification in this paper because it allows me to maintain the same functional form across all conditions. For example, some conditions do not have an inflection point at 14 years of maternal educational attainment.
a health condition. However, for children of mothers who have completed some college, each year of schooling is associated with a lower probability of having any health condition. As discussed earlier, this inverse-U-shaped maternal education gradient is consistent with both of the countervailing hypotheses that I offer. Increased knowledge and symptom recognition implied by each year of schooling increase the probability of a parent identifying and reporting a condition, but only to a certain point. Above that point (14 years of educational attainment), knowledge does not appreciably increase recognition of a condition and its symptoms, whereas other parental resources (such as income and family structure) could reduce the risk of a health symptom.

To examine this interpretation, Columns 2-4 of Table 3.2 sequentially introduce measures of income, family structure, and insurance status to logistic regression models, such that the final column includes all explanatory factors simultaneously. These models reveal the extent to which better-educated mother’s location within more health-advantageous family configurations, possession of more income, and higher likelihood of having health insurance coverage than less-educated mothers shape maternal gradient in child conditions.

Including these measures adds very little to our understanding of why more-educated mothers are more likely to report that their child has a health condition than are less-educated mothers. To highlight this point more concretely, the three additional lines on Figure 3.3 correspond to the predicted probability of having any condition across maternal educational attainment calculated from Table 3.2, Models 2-4.

Two main findings stand out in these additional graphs. First, differences in economic and non-economic resources (income, family structure, and health insurance coverage) across levels of maternal schooling mainly affect the strength of the association between maternal
education and health conditions among children of the most educated mothers, as indicated by a “flatter” right-hand side of the inverted-U shape. Part of the reason each year of increased schooling above 14 years is associated with a lower probability of a child’s having a health condition is because mothers with increasing levels of schooling have greater incomes and increased likelihoods of having health insurance coverage and advantageous family structures.

Second, differences between the four nested models are small, and their predicted probability curves are barely distinguishable from one another (differences between predicted probabilities are not significant). This similarity between models means that even though children of more-educated mothers have more income and are more likely to have health insurance, these differences fail to explain why children of better-educated mothers are more likely to have a reported health condition. This finding also suggests that most of the positive education gradient in children’s health conditions is due to characteristics of mothers that are not measured in my model.

**Condition-specific gradients**

[Figure 3.4 about here]

Results thus far offer a broad overview of the association between maternal education and whether a child has any reported health condition. This measure of child health potentially obscures variation across specific health conditions. As discussed above, there are differences in the extent to which parental knowledge and/or conscientiousness is required to recognize symptoms or seek a diagnosis and these differences may help account for the fact that children of more-educated mothers have more reported health conditions. Figure 3.4 plots the bivariate association between mother’s education and the percentage of children with each of the eleven conditions described in Table 3.1. Across conditions, there is substantial variation in the
magnitude and shape of the maternal education gradient. Some conditions (e.g., asthma) exhibit the same inverted-U gradient described above, whereas other conditions show a linear gradient (e.g., food allergies) or no gradient (e.g., autism).

To assess whether these differences persist net of differences in income, family structure, and health insurance status across levels of maternal education, I estimate logistic regressions for each health condition separately. I present results from models that include only basic demographic controls (Model 1 above) and models that include income, family structure (father’s presence, mother’s age at birth, and number of siblings), and health insurance status (Model 4 above). As with the summary measure, additional regressions suggest that sequentially adding these economic and non-economic resources (Models 2-4 above) to the model does not alter the basic findings. I present log-odds estimates in Table 3.3, and graph predicted probabilities in Figure 3.5.

[Table 3.3 and Figure 3.5 about here]

Condition-specific results are fairly consistent with hypotheses that emphasize the importance of parental knowledge for recognizing and reporting health conditions. Three of the eleven conditions are physician diagnosed: asthma, autism, and attention-deficit hyperactivity disorder (ADHD). By definition, having one of these conditions means that a parent has taken the child to a doctor and described his symptoms to the physician. Diagnosed conditions, therefore, require more income, parent-child interactions, and maternal knowledge to identify the symptom, take a child to the appropriate source of care, and interact with the health care system than do the other eight health conditions.

Both asthma and ADHD diagnoses exhibit the same inverted-U-shaped pattern as the summary measure of having any condition. However, there is no evidence for a statistically
significant education gradient among children with autism. The relative rarity of autism (0.61 percent of the total sample) does not allow me to distinguish between a true lack of a maternal education gradient in autism and insufficient statistical power to detect a difference.

Findings for the three types of allergies—respiratory, skin, and food allergies—are also hypothesized to have positive gradients. Unlike asthma, these conditions are not necessarily physician diagnosed, but all three require repeated parental involvement and conscientiousness to discern the allergic pattern, even if the symptoms are fairly noticeable. Consistent with this perspective, children’s likelihood of having respiratory, skin, and food allergies increases linearly with maternal schooling.

Five of the health conditions examined—frequent diarrhea, frequent headaches, vision problems, stutter/stammer, and ear infections—have symptoms that are immediately recognizable and are of a long duration. Educated mothers’ knowledge and increased access to health care are not expected to substantially influence the identification of these conditions and thus we would not expect to find a positive association between maternal education and one of these conditions.

Results for all of these conditions fit the hypothesis that maternal education is not positively associated with the report of a recognizable condition. Despite statistically significant differences across levels of maternal schooling, there is no substantively meaningful change in a child’s likelihood of having frequent diarrhea, frequent headaches, vision problems, or stutter/stammer across levels of maternal schooling. This finding may be due to the non-preventable nature of many diseases. Vision problems can be addressed with corrective lenses, but not prevented; classmates and playmates expose even the most advantaged children to various diarrhea-causing infections.
Taken together, these condition-specific diagnosis trends offer some leverage in interpreting earlier findings. Children of more-educated mothers are more likely than children of less-educated mothers to have reported conditions that require health care access or recognition of symptoms that are generally not immediately identifiable. In contrast, increasing maternal education is not associated with an increasing likelihood that children will experience conditions that have immediately recognizable symptoms (diarrhea, vision impairments, stutter/stammer, and ear infections). Together, findings from specific health conditions suggest that parental monitoring and symptom recognition could be driving the maternal education gradient. These pathways cannot be tested directly, but they are consistent with prior work (e.g., King and Bearman 2011), which demonstrates that health-related knowledge and the ability to identify symptoms help explain why better-educated mothers tend to have children with a reported health condition.

**Has the association between mother’s education and children’s health conditions changed across 1979-2013 birth cohorts?**

I now move from a cross-sectional consideration of the maternal education gradient in health conditions to an examination of how this gradient may have changed across 1979-2013 birth cohorts. Investigating whether patterns vary across cohorts helps to uncover whether children’s health burdens have shifted across time and helps to reveal which characteristics of better-educated mothers shape the gradient. As noted above, I hypothesize that the maternal education gradient in health conditions weakened across birth cohorts because of rising educational attainment and improved health knowledge. However, rising social inequality related to parent-child dynamics may offset some of the expected declines across cohorts.
Cohort trends in any health condition

[Table 3.4 about here]

Once again, I start with a broad overview and focus on cohort trends in the association between maternal schooling and having any health condition (Table 3.4). The coefficients on the main term for education and education-squared (not shown) replicate findings from above. Higher levels of maternal education are associated with higher odds of reporting a health condition, but this gradient levels off and reverses for women who have attended post-secondary schooling. However, the significant negative coefficient on the interaction term suggests that this gradient weakened across 1979-2013 cohorts. That is, having a mother with more education was less predictive of health conditions for children born in 2013 than for children born in 1979. This decline persists even after adjusting for differences in income, family structure, and insurance status across maternal education (Column 2). The increasingly unequal distributions of income and family structure that contributed to a declining education gradient in children’s subjective health (see previous chapter) are not meaningfully contributing to the cohort trend for health conditions.16

[Figure 3.6 about here]

The above estimates are in the log-odds scale, which obscures whether cohort changes were substantively meaningful. To provide a sense of the magnitude of change, Figure 3.6 plots the predicted coefficient of the maternal education gradient in child health conditions, adjusted for family structure, income, and health insurance differences (Table 3.4, Column 2) for children born in 1979 (oldest cohort), 1996 (middle cohort), and 2013 (youngest cohort).

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16 Two-way interactions between each of the explanatory pathways and cohort also did not substantially alter estimates.
These predicted values indicate that the positive maternal education gradient in child health substantially decreased across 1979-2013 birth cohorts. Across cohorts, mother’s educational attainment became a weaker predictor of children’s health conditions. That is, children across all levels of maternal education experienced cohort declines in the effect of maternal education on reported health conditions (indicated by the different heights of the three lines across the full span of the x-axis). Insofar as the gradient captures parents’ ability to detect symptoms rather than actual “objective” health differences, such cohort declines are consistent with rising maternal educational attainment and increasing access to health care and knowledge that affected children born in the latter part of the twentieth century. Given that I observe a weakening education gradient in health conditions across birth cohorts, increased parent-child time (hypothesized to strengthen gradients across cohorts) cannot be the primary influence propelling observed trends.

Furthermore, cohort declines were uneven: the magnitude of declines in the maternal education gradient in health conditions across cohorts was not the same for children with mothers of different levels of educational attainment (indicated by different shapes for the three lines). Children of the most educated mothers experienced larger declines in the effect of mother’s education on the report of a health condition than children of less-educated mothers experienced. As a result, the maternal education gradient has become “flatter” across cohorts. This pattern of larger declines at the top of the maternal education distribution is consistent with the diffusion of knowledge across society and increased health access affecting the importance of maternal education for child health.
Variation in cohort trends across conditions

[Table 3.5 about here]

Table 3.5 presents the results for condition-specific logistic regressions. Across specific health conditions, there are relatively few meaningful changes in the association between mother’s education and children’s experience of a health condition across birth cohorts. Only maternal education gradients in children’s asthma, respiratory allergy, skin allergy, and ear infections have significantly decreased across birth cohorts. That is, across children born between 1979 and 2013, mother’s education has become a weaker predictor of whether a child has one of these four health conditions. None of the other seven gradients have increased or decreased in magnitude across cohorts.

[Figure 3.7 about here]

To offer a better sense of the magnitude and substantive importance of these changes, Figure 3.7 plots the predicted “effect” of maternal education on each of the eleven conditions calculated from Model 2 in Table 3.5.\(^{17}\) Only maternal education gradients in asthma and respiratory allergies show any substantively meaningful decreases across cohorts. Larger absolute and relative cohort declines have occurred for asthma than for respiratory allergies, but both conditions exhibit the same basic cohort trends as each other and as for the maternal education gradient in having any health condition. Across 1979-2013 birth cohorts, the relationships between mother’s education and asthma and between mother’s education and respiratory allergies weakened for children of mothers at all levels of schooling, with larger declines among children of mothers with postsecondary schooling than for children of less-educated mothers.

\(^{17}\)Cohort predictions that are “missing” from Figure 3.7 are actually present, but overlap with one or more of the other predicted lines.
These results are most consistent with the prospect that increased access to health care (through SCHIP and other policies) and more accessible health knowledge among less-educated mothers have propelled trends in the maternal education gradient across birth cohorts. If trends were mainly driven by increasing social inequality across cohorts, then we would expect maternal education gradients to have strengthened across cohorts. If cohort trends in the maternal education gradient were mainly driven by decreased educational selectivity across cohorts, then we would expect maternal education gradients to have weakened for both diagnoses and for allergies, not for only one condition within each category. There is no *a priori* reason to expect that expanded access to educational attainment across the twentieth century would have an effect only on education as a marker for advantage related to only asthma and respiratory allergies. Yet we fail to see trends for autism, ADHD, and food and skin allergies.

**DISCUSSION AND CONCLUSION**

Reported conditions provide a crucial metric for measuring the health status of American children. Decisions about the allocation of medical resources and the assessment of progress toward ameliorating health disparities, for example, each depend on estimates of diagnosed conditions (e.g., Centers for Disease Control 2012; Department of Health and Human Services 2010). Although prior research has investigated the relationship between family income and reported health conditions and the relationship between maternal education and subjective measures of health, there is a lack of research examining children’s health conditions across levels of maternal education. In this chapter, I extended considerations of maternal education’s influence on child health beyond subjective health to examine its influence on reported health conditions.
In contrast to the education gradient in subjective health (see previous chapter) and the income gradient in diagnosed conditions (e.g., asthma, diabetes, digestive disorders) (Case, Lubotsky, and Paxson 2002), children of educated mothers are more likely to have a health condition than their less advantaged counterparts, but only up to a point. Among children of mothers with less than 14 years of schooling, children of more-educated mothers are more likely to have at least one condition than children of less-educated mothers. Children’s likelihood to suffer from at least one health condition decreases with each year of maternal educational attainment above 14 years.

These findings are likely not attributable to the children of better-educated mothers having “worse” health and more negative health events than children of less-educated mothers. Rather findings likely reveal the ways in which mothers who attained more education tend to be better positioned to notice the early onset of symptoms or low-severity symptoms than those who attained less education (Bearman and King 2011; Ziol-Guest and Dunifon 2014).

For example, educated mothers are more involved in their children’s activities and more closely monitor their children’s behaviors than those who attain less education (Suizzo and Stapleton 2007). They are also more likely than less-educated mothers to be health conscientious and to have greater health knowledge, either as a consequence of their education or as a consequence of preferences that jointly determine both education and health behaviors (Fuchs 1982). These behaviors and preferences may mean that more-educated mothers are better positioned than less-educated mothers either to “over-diagnose” minor conditions or to detect emerging illnesses before they become too severe.

Unmeasured aspects of maternal parenting styles and health knowledge might account for a large share of the remaining gradient in children’s reported health conditions. The slowdown
and reversal of this pattern among the most educated mothers suggests that knowledge only matters up to a point; that is, a certain level of education could provide sufficient conscientiousness and health knowledge to identify and report conditions, whereas greater maternal education may actually reduce a child’s chances of having a reported health condition.

Although I was unable to test this hypothesis directly, separate analyses of eleven indicators of health offer indirect support for it. Children of more-educated mothers are no more or less likely to have conditions that have fairly obvious and recognizable symptoms, such as stuttering, blurred vision, and diarrhea, than their less advantaged peers. The recognizability of symptoms and their consequences means that identification of these conditions is not sensitive to a mother’s medical knowledge or the time she spends with her children.

However, health conditions that are physician diagnosed (e.g., asthma) generally exhibited the same inverted-U pattern as the summary measure of health conditions: children are more likely to have a diagnosed condition with each year of maternal schooling, but only for those born to mothers with less than some post-secondary education. Likewise, for the final category of specific conditions, I also observe that children of mothers with an additional year of education are more likely to have allergies than children of mothers with just one less year of schooling. Because mothers must recognize sometimes low-severity and difficult to identify symptoms (e.g., with autism) over repeated observations (e.g., with allergies) and possibly take their child to a physician for these conditions (for diagnosis and/or allergy tests), their identification is more sensitive to mothers’ knowledge and preferences than for conditions I deem “recognizable.”

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18 One possible explanation for why children of more-educated parents are not less likely to have these conditions is that less-educated parents might also misremember their children’s diagnoses and underreport them more often than do better-educated mothers (Baker, Stabile, and Deri 2001).
My analyses also examined whether the connection between maternal education and children’s health conditions has changed across birth cohorts. Across the late-twentieth century and early-twenty-first century, basic improvements in children’s floor level of wellbeing have occurred against a backdrop of rising social inequality. Children born in more recent years have tended to have more-educated mothers with greater access to health information than children in prior years, but disparities between advantaged and disadvantaged children have widened during the same time period. Investigating whether the basic cross-sectional pattern varies by when children are born helps to highlight whether children’s health burdens have shifted across time and offers some leverage in disentangling the relative importance of maternal knowledge and symptom recognition from other family resources.

I find the maternal education gradient in children’s health conditions has weakened across children’s birth cohorts. However, children of mothers with at least a high school education have experienced greater declines in the effect of maternal education on reported health conditions than those with less than a high school degree. This unevenness has two important implications. First, it supports the notion that the increasing educational attainment and increasing access to health care and medical knowledge that began in the mid-twentieth century has influenced children’s health patterns. “Rising tides” and other improvements in the floor level of children’s wellbeing have substantially influenced the context of the production and reporting of children’s health. Second, insofar as my assumption that reporting differences mainly drive the maternal education gradient in health conditions is correct, it is important to recognize that differences in health condition reporting practices have likely changed over time. Thus policymakers’ estimates of cohort change in children’s health inequalities are the result of
both change in actual health risks and more- and less-educated parents’ increasingly similar reporting practices of health conditions.

Once again, separate analyses of specific indicators offer indirect support for my hypotheses concerning the potential importance of maternal knowledge and symptom recognition. Only maternal education gradients in asthma and respiratory allergies, which are positive, show substantively meaningful decreases across birth cohorts. These two health conditions have symptoms that are similar to each another, and both conditions have become more common across 1979-2013 birth cohorts (Akinbami et al. 2009; Delaney and Smith 2012; Smith 1999). Prior research demonstrates growth in black-white asthma disparities between 1998 and 2013 (Mehta et al. 2013), which suggests that increased asthma prevalence or improved detection among the less advantaged families might be driving trends.

On the surface, these cohort findings are consistent with a story in which improvements in general wellbeing account for trends. Increased educational opportunities (Hout 2012) and improved access to health services (Currie 2008) each suggest declines in the association between mother’s tastes, skills, and knowledge and children’s diagnosis of a condition. But an examination of cohort trends in the maternal education finds only declines in maternal education gradients in asthma and respiratory allergies. The limited nature of declines in maternal education gradients across cohorts suggests that my results should not be taken as evidence that basic improvements in knowledge and health care have offset rising social inequality. To the extent that I fail to observe increasing disparities among children of the most advantaged mothers, such inequality might have been offset by education and knowledge expansion across cohorts.
However, there are at least two other possible explanations for these findings. First, rising inequality itself might have offsetting implications. Compared to poorer and less-educated families, the most advantaged families have disproportionately increased the amount of time and money invested in their children (Kornich and Furstenberg 2012; Ramey and Ramey 2010). These investments might have improved their children’s level of actual health. Although the most advantaged mothers might have become better able to detect their children’s symptoms, there might have been a decrease in the number of symptoms for them to detect. Second, improvements in knowledge and education have not improved less-educated mothers’ recognition of symptoms across birth cohorts; rather, social inequality has increased their children’s likelihood of actually having health conditions. Future research should attempt to disentangle these possibilities. Future research should also attempt to discern whether increases in the number of reported conditions across recent decades (Delaney and Smith 2012) means that children have become sicker or that mothers have become closer monitors of their children’s health.

In this chapter, I have moved from the previous chapter’s focus on subjective health status to examine what mother’s educational attainment means for children’s reported health conditions. Taken together, my results suggest that maternal educational advantage protects child health, but unobserved characteristics of better-educated mothers mean that they might be more likely to identify and report health conditions than less-educated mothers. If this interpretation is indeed correct, research that uses reported conditions may underestimate socioeconomic disparities in child health. Across cohorts, health differences between children of more-educated mothers and children of less-educated mothers have attenuated, signaling a true epidemiologic shift or a shift in the meaning of the health measure.
TABLES AND FIGURES

Figure 3.1. Conceptual model of the relationship between mother’s education, child health, and specific health conditions

Note: Solid lines represent paths described in both the previous chapter and in the present chapter; dashed lines represent paths introduced in this analytic chapter.
Table 3.1. Description of health measures and their prevalence, 1997-2013 NHIS Sample Child Files

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
<th>Prevalence</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Ever diagnosed with asthma</td>
<td>13.23</td>
<td>137,504</td>
</tr>
<tr>
<td>Allergies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>Respiratory allergy or hay fever in past 12 months</td>
<td>12.22</td>
<td>136,788</td>
</tr>
<tr>
<td>Skin</td>
<td>Skin allergy in past 12 months</td>
<td>10.39</td>
<td>137,025</td>
</tr>
<tr>
<td>Food</td>
<td>Food allergy in past 12 months</td>
<td>4.52</td>
<td>136,944</td>
</tr>
<tr>
<td>Frequent</td>
<td>Frequent headaches/migraines in past 12 months</td>
<td>6.50</td>
<td>113,505</td>
</tr>
<tr>
<td>Frequent diarrhea</td>
<td>Frequent or repeated diarrhea in past 12 months</td>
<td>1.62</td>
<td>137,102</td>
</tr>
<tr>
<td>Ear infection</td>
<td>≥ 3 ear infections in past 12 months</td>
<td>6.52</td>
<td>137,087</td>
</tr>
<tr>
<td>Vision problem</td>
<td>Trouble seeing even when wearing glasses or contact lens in the past 12 months</td>
<td>2.55</td>
<td>137,448</td>
</tr>
<tr>
<td>Stutter /stammer</td>
<td>Stutter/stammer in past 12 months</td>
<td>1.77</td>
<td>113,525</td>
</tr>
<tr>
<td>ADHD</td>
<td>Ever diagnosed as having attention deficit disorder or attention deficit hyperactivity disorder</td>
<td>6.79</td>
<td>121,227</td>
</tr>
<tr>
<td>Autism</td>
<td>Ever diagnosed with autism</td>
<td>0.61</td>
<td>137,611</td>
</tr>
</tbody>
</table>
Figure 3.2. Cross-sectional association between maternal educational attainment and percent of children with a diagnosed condition

Data: 1997-2013 NHIS Sample Child Files.
Note: See Table 1 for descriptions of conditions that comprise the summary measure
### Table 3.2: Coefficients (and standard errors) from logistic regression estimates of cross-sectional association between maternal education and any childhood health condition

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat. Ed.</td>
<td>.139 (.010)**</td>
<td>.127 (.010)**</td>
<td>.123 (.010)**</td>
<td>.115 (.010)**</td>
</tr>
<tr>
<td>Mat. Ed.(^2)</td>
<td>-.005 (.004)**</td>
<td>-.004 (.004)**</td>
<td>-.003 (.004)**</td>
<td>-.003 (.004)**</td>
</tr>
<tr>
<td>Family structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Father present</td>
<td>-.382 (.014)**</td>
<td>-.326 (.016)**</td>
<td>-.312 (.016)**</td>
<td></td>
</tr>
<tr>
<td>Mother &lt; 25</td>
<td>-.019 (.021)</td>
<td>-.031 (.022)</td>
<td>-.026 (.022)</td>
<td></td>
</tr>
<tr>
<td>Mother &gt; 35</td>
<td>-.012 (.016)</td>
<td>-.005 (.016)</td>
<td>-.006 (.016)</td>
<td></td>
</tr>
<tr>
<td># siblings</td>
<td>-.066 (.006)**</td>
<td>-.067 (.006)**</td>
<td>-.069 (.006)**</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>-.021 (.003)**</td>
<td>-.026 (.003)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has insurance</td>
<td></td>
<td></td>
<td></td>
<td>.284 (.020)**</td>
</tr>
</tbody>
</table>

* * p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: 1997-2013 NHIS Sample Child Files.

Note: See Table 1 for descriptions of conditions that comprise the summary measure. All models control for children’s age, race, ethnicity, region, and sex.
Figure 3.3. Predicted association between maternal education and any childhood health condition

Data: 1997-2013 NHIS Sample Child Files.
Note: Estimates predicted from logistic regression models described in Table 2. All covariates set to mean values.
Figure 3.4. Cross-sectional association between maternal education and specific child health conditions

Data: 1997-2013 NHIS Sample Child Files covariates set to mean values
Table 3.3. Coefficients (and standard errors) from logistic regression estimates of the association between maternal education and specific child health conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Asthma, Ever</th>
<th>Respiratory Allergy</th>
<th>Food allergy</th>
<th>Skin allergy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat. educ.</td>
<td>.225*** (.018)</td>
<td>.180*** (.020)</td>
<td>.091*** (.030)</td>
<td>.163*** (.020)</td>
</tr>
<tr>
<td></td>
<td>.177*** (.017)</td>
<td>.158*** (.020)</td>
<td>.076*** (.028)</td>
<td>.136*** (.020)</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>-.008*** (.001)</td>
<td>-.005*** (.001)</td>
<td>-.001</td>
<td>-.004*** (.001)</td>
</tr>
<tr>
<td></td>
<td>-.006*** (.001)</td>
<td>-.004*** (.001)</td>
<td>-.0003</td>
<td>-.003*** (.001)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequent diarrhea</th>
<th>Frequent headache</th>
<th>Ear infection</th>
<th>Vision problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat. educ.</td>
<td>.115** (.039)</td>
<td>.109*** (.023)</td>
<td>.053** (.019)</td>
<td>.058* (.029)</td>
</tr>
<tr>
<td></td>
<td>.067† (.038)</td>
<td>.060** (.023)</td>
<td>.020</td>
<td>.020</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>-.006*** (.002)</td>
<td>-.006*** (.001)</td>
<td>-.003***</td>
<td>-.004***</td>
</tr>
<tr>
<td></td>
<td>-.003† (.002)</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.001)</td>
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<table>
<thead>
<tr>
<th>Condition</th>
<th>Stutter/stammer</th>
<th>Autism</th>
<th>ADHD</th>
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<tbody>
<tr>
<td>Mat. educ.</td>
<td>.090* (.037)</td>
<td>.120 (.084)</td>
<td>.242*** (.029)</td>
</tr>
<tr>
<td></td>
<td>.033 (.037)</td>
<td>.118 (.056)</td>
<td>.205*** (.029)</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>-.007*** (.002)</td>
<td>-.001 (.003)</td>
<td>-.009*** (.001)</td>
</tr>
<tr>
<td></td>
<td>-.002 (.002)</td>
<td>.0002 (.003)</td>
<td>-.007*** (.001)</td>
</tr>
</tbody>
</table>

* p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: 1997-2013 National Health Interview Survey (NHIS) Sample Child files

Note: Model 1 controls for age, age-squared, period, race/ethnicity, sex, and region, and includes interactions between mother’s education and each of age and age-squared. Model 2 adds family income decile, father’s presence, mother’s age at birth, number of siblings, and health insurance status.
Figure 3.5. Predicted association between maternal education and specific child health conditions

Data: 1997-2013 NHIS Sample Child Files.
Note: Results in “Controls” model from logistic regression models that include age, age-squared, period, race/ethnicity, sex, and region. The “Full” model adds measures of family income decile, father’s presence, mother’s age at birth, number of siblings, and health insurance status. All covariates set to mean values.
Table 3.4. Coefficients (and standard errors) from logistic regression estimates of cohort trends in the association between maternal education and any childhood health condition, 1979-2013 birth cohorts

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal education</td>
<td>.158(.012)***</td>
<td>.129(.012)***</td>
</tr>
<tr>
<td>Maternal education²</td>
<td>-.005(.0004)***</td>
<td>-.003(.0004)***</td>
</tr>
<tr>
<td>Cohort</td>
<td>-.028(.008)***</td>
<td>-.031(.008)***</td>
</tr>
<tr>
<td>Maternal educ x cohort</td>
<td>-.001(.0004)***</td>
<td>-.001(.0004)*</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td>-.027(.003)***</td>
</tr>
<tr>
<td>Family structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Father present</td>
<td></td>
<td>-.299(.015)***</td>
</tr>
<tr>
<td>Mother &lt; 25</td>
<td></td>
<td>-.021(.022)</td>
</tr>
<tr>
<td>Mother &gt; 35</td>
<td></td>
<td>-.010(.016)</td>
</tr>
<tr>
<td># siblings</td>
<td>-.066(.006)***</td>
<td></td>
</tr>
<tr>
<td>Has insurance</td>
<td></td>
<td>.270(.020)***</td>
</tr>
</tbody>
</table>

* p ≤ .05, ** p ≤ .01, *** p ≤ .001

Note: Model 1 controls for age, age-squared, period, race/ethnicity, sex, region, and mother’s work status and includes interactions between mother’s education and each of age and age-squared. Model 2 adds information about father’s presence, mother’s age at birth, number of siblings, and health insurance status.
Figure 3.6. Plot of the predicted coefficient of maternal education on any health condition, by cohort

Predicted gradient from model (2) in previous table. Models control for age, age-squared, period, race/ethnicity, sex, region, and mother’s work status, father’s presence, mother’s age at child’s birth, number of siblings, and health insurance status, and includes interactions between mother’s education and each of age and cohort. All covariates set to mean values.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Asthma, Ever</th>
<th>Respiratory Allergy</th>
<th>Food allergy</th>
<th>Skin allergy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cohort</strong></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Mat. educ.</td>
<td>.047(.009)**</td>
<td>-.011(.012)</td>
<td>.027(.009)**</td>
<td>-.001(.012)</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>.262(.021)**</td>
<td>.205(.024)**</td>
<td>.217(.002)**</td>
<td>.185(.022)**</td>
</tr>
<tr>
<td>Educ. x cohort</td>
<td>-.009(.001)</td>
<td>-.006(.001)**</td>
<td>-.004(.001)**</td>
<td>-.004(.001)**</td>
</tr>
<tr>
<td><strong>Frequent diarrhea</strong></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Cohort</td>
<td>.023(.021)</td>
<td>.012(.030)</td>
<td>.002(.012)</td>
<td>-.027(.017)</td>
</tr>
<tr>
<td>Mat. educ.</td>
<td>.149(.047)**</td>
<td>.090(.046)*</td>
<td>.115(.028)**</td>
<td>.057(.028)*</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>-.006(.002)**</td>
<td>-.002(.002)</td>
<td>-.006(.001)**</td>
<td>-.003(.001)**</td>
</tr>
<tr>
<td>Educ. x cohort</td>
<td>-.002(.002)</td>
<td>-.002(.002)</td>
<td>-.001(.001)</td>
<td>-.001(.001)</td>
</tr>
<tr>
<td><strong>Frequent headache</strong></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Cohort</td>
<td>.012(.021)</td>
<td>-.018(.030)</td>
<td>.043(.014)**</td>
<td>-.026(.018)</td>
</tr>
<tr>
<td>Mat. educ.</td>
<td>.060(.044)</td>
<td>-.005(.043)</td>
<td>.238(.033)**</td>
<td>.186(.033)**</td>
</tr>
<tr>
<td>Mat. educ.²</td>
<td>-.008(.002)**</td>
<td>-.003(.002)*</td>
<td>-.011(.001)**</td>
<td>-.008(.001)**</td>
</tr>
<tr>
<td>Educ. x cohort</td>
<td>-.002(.002)</td>
<td>.002(.002)</td>
<td>-.001(.001)</td>
<td>.0001(.001)</td>
</tr>
</tbody>
</table>

* p ≤ .05, ** p ≤ .01, *** p ≤ .001

**Data:** 1997-2013 National Health Interview Survey (NHIS) Sample Child files

**Note:** Model 1 controls for age, age-squared, period, race/ethnicity, sex, and region, and includes interactions between mother’s education and each of age and age-squared. Model 2 adds family income decile, father’s presence, mother’s age at birth, number of siblings, and health insurance status.
Figure 3.7. Plot of the predicted coefficient of mother’s education on probability of diagnosis, by birth cohort

Predicted from model (2) in previous table. Models control for age, age-squared, period, race/ethnicity, sex, region, and mother’s work status, father’s presence, mother’s age at child’s birth, number of siblings, and health insurance status, and includes interactions between mother’s education and each of age and cohort.
### APPENDIX

Table 3.A1. Percentages or means (and standard deviation) for primary characteristics, 1997-2013 NHIS Sample Child files

<table>
<thead>
<tr>
<th></th>
<th>Mother’s education</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 12 years (15.76%)</td>
<td>≥ 12 years (84.24%)</td>
<td></td>
</tr>
<tr>
<td>Any health conditions (%)</td>
<td>33.22</td>
<td>41.23</td>
<td></td>
</tr>
<tr>
<td>Health (1-5)</td>
<td>4.09 (.93)</td>
<td>4.42 (.78)</td>
<td></td>
</tr>
<tr>
<td>“Excellent” or “very good” (%)</td>
<td>70.65</td>
<td>85.58</td>
<td></td>
</tr>
<tr>
<td>Family income (1999 USD)</td>
<td>25,503(22,196)</td>
<td>61,213 (45,085)</td>
<td></td>
</tr>
<tr>
<td>Father present (%)</td>
<td>72.34</td>
<td>77.21</td>
<td></td>
</tr>
<tr>
<td>Mother &lt; 25 at birth (%)</td>
<td>14.31</td>
<td>7.26</td>
<td></td>
</tr>
<tr>
<td>Mother &gt;35 at birth (%)</td>
<td>74.08</td>
<td>14.57</td>
<td></td>
</tr>
<tr>
<td>Siblings (#)</td>
<td>1.23 (.62)</td>
<td>1.00 (.60)</td>
<td></td>
</tr>
<tr>
<td>Has health insurance (%)</td>
<td>75.31</td>
<td>92.49</td>
<td></td>
</tr>
<tr>
<td>Mother employed (%)</td>
<td>44.42</td>
<td>65.71</td>
<td></td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>8.70 (5.24)</td>
<td>8.51</td>
<td></td>
</tr>
<tr>
<td>Female (%)</td>
<td>48.81</td>
<td>48.95</td>
<td></td>
</tr>
<tr>
<td>South (%)</td>
<td>37.18</td>
<td>36.31</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White (%)</td>
<td>78.19</td>
<td>76.13</td>
<td></td>
</tr>
<tr>
<td>Black (%)</td>
<td>11.18</td>
<td>16.31</td>
<td></td>
</tr>
<tr>
<td>Other (%)</td>
<td>10.64</td>
<td>7.56</td>
<td></td>
</tr>
<tr>
<td>Hispanic (%)</td>
<td>78.32</td>
<td>20.07</td>
<td></td>
</tr>
</tbody>
</table>

Data: 1997-2013 NHIS Sample Child Files

Note: Analytic sample varies across the specific conditions examined. See Data and Methods section for additional detail
Figure 3.A1. Comparison of logistic regression and linear probability (OLS) estimates of the maternal education gradient in children’s health conditions.
Table 3.A2. Correlations between chronic conditions and parent-rated subjective health

<table>
<thead>
<tr>
<th>Condition</th>
<th>Correlation with 1-5 subjective health status&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Correlation with “very good” or “excellent” health status&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever diagnosed</td>
<td>-0.1665</td>
<td>-0.2842</td>
</tr>
<tr>
<td>ER visit&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.1918</td>
<td>-0.2885</td>
</tr>
<tr>
<td>Allergies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>-0.1032</td>
<td>-0.1742</td>
</tr>
<tr>
<td>Skin</td>
<td>-0.0623</td>
<td>-0.1182</td>
</tr>
<tr>
<td>Food</td>
<td>-0.0662</td>
<td>-0.1521</td>
</tr>
<tr>
<td>Frequent headache</td>
<td>-0.1225</td>
<td>-0.2536</td>
</tr>
<tr>
<td>Frequent diarrhea</td>
<td>-0.0774</td>
<td>-0.2428</td>
</tr>
<tr>
<td>Ear infection</td>
<td>-0.0704</td>
<td>-0.1491</td>
</tr>
<tr>
<td>Vision problem</td>
<td>-0.0764</td>
<td>-0.2209</td>
</tr>
<tr>
<td>Stutter or stammer</td>
<td>-0.0848</td>
<td>-0.2632</td>
</tr>
<tr>
<td>Psychological</td>
<td>-0.1016</td>
<td>-0.2216</td>
</tr>
</tbody>
</table>

All correlations are statistically significant at the p < .001 level.

<sup>a</sup> Point-biserial correlations; higher health statuses correspond to better health

<sup>b</sup> Tetrachoric correlations

<sup>c</sup> Among children diagnosed with asthma

Data: 1997-2013 NHIS Sample Child files
Table 3.A3. Linear probability estimates of maternal education gradient in health conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Asthma, Ever (1)</th>
<th>Asthma, Ever (2)</th>
<th>Respiratory Allergy (1)</th>
<th>Respiratory Allergy (2)</th>
<th>Food allergy (1)</th>
<th>Food allergy (2)</th>
<th>Skin allergy (1)</th>
<th>Skin allergy (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal educ.</td>
<td>.019*** (.001)</td>
<td>.014*** (.002)</td>
<td>.009*** (.001)</td>
<td>.008*** (.001)</td>
<td>.001 (.001)</td>
<td>.0007 (.0009)</td>
<td>.007*** (.001)</td>
<td>.005*** (.001)</td>
</tr>
<tr>
<td>Maternal educ.²</td>
<td>- .001*** (.0001)</td>
<td>- .0004*** (.0001)</td>
<td>- .0001* (.0001)</td>
<td>- .0001* (.0001)</td>
<td>.00004 (.0003)</td>
<td>.0001* (.0001)</td>
<td>- .0001 (.0001)</td>
<td>- .0000001 (.0001)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequent diarrhea (1)</th>
<th>Frequent headache (1)</th>
<th>Ear infection (1)</th>
<th>Vision impairment (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal educ.</td>
<td>.002** (.001)</td>
<td>.001† (.001)</td>
<td>.006*** (.001)</td>
<td>.003* (.001)</td>
</tr>
<tr>
<td>Maternal educ.²</td>
<td>- .0001*** (.00002)</td>
<td>- .00004† (.00002)</td>
<td>- .003** (.0001)</td>
<td>- .0001** (.0001)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Speech impairment (1)</th>
<th>Autism (1)</th>
<th>ADHD (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal educ.</td>
<td>.0007 (.0006)</td>
<td>.0001 (.0001)</td>
<td>.00007 (.0003)</td>
</tr>
<tr>
<td>Maternal educ.²</td>
<td>- .000008 (.000002)</td>
<td>.00002 (.00003)</td>
<td>- .0004*** (.00004)</td>
</tr>
</tbody>
</table>

* p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: 1997-2013 National Health Interview Survey (NHIS) Sample Child files

Note: Model 1 controls for age, age-squared, period, race/ethnicity, sex, and region, and includes interactions between mother’s education and each of age and age-squared. Model 2 adds family income decile, father’s presence, mother’s age at birth, number of siblings and health insurance status.
Figure 3.A2. Plot of the predicted percentage of children across (cohort-centered) maternal education by cohort, specific health conditions

Data: 1997-2013 NHIS Sample Child Files
Note: Models control for age, age-squared, period, race/ethnicity, sex, and region, and includes interactions between mother’s education and each of age and age-squared, family income decile, father’s presence, mother’s age at birth, number of siblings and health insurance status. All covariates set to means.
Figure 3.A3. Comparison of trends in maternal education gradient, with and without cohort variation in quadratic education.
Figure 3.A4. Plot of the predicted association between mother’s education and probability of diagnosis, by birth cohort

Predicted from model (2) in previous table. Models control for age, age-squared, period, race/ethnicity, sex, region, and mother’s work status, father’s presence, mother’s age at child’s birth, number of siblings, and health insurance status, and includes interactions between mother’s education and each of age and cohort. All covariates set to means.
Chapter 4: Birth weight and educational attainment across birth cohorts

Early-life health has a “long arm” across individuals’ lives. Low birth-weight children attain less schooling compared to those who weighed more at birth (Conley and Bennett 2000, 2001; Johnson and Schoeni 2007; Royer 2009). Although a large body of research has documented the educational consequences of early-life health, no work has examined whether these consequences depend on when individuals were born. Yet social contexts underwent dramatic transformation during the mid-twentieth century that have allowed individuals to enjoy healthier childhoods and expanded educational opportunities. These improvements may have modified the extent to which low birth-weight children complete less schooling than their healthier counterparts.

An examination of cohort variation in the association between low birth weight and educational attainment provides crucial insight into the life-course implications of the diminishing inequality described in earlier dissertation chapters. Specifically, what are the longer-term implications of weakening education gradients in children’s health? Diminishing or strengthening educational consequences of low birth weight amplify or offset the declining importance of child health for intergenerational cycles of disadvantage. A careful consideration of the interplay between childhood health and the production of educational attainment is, therefore, a necessary focus of any consideration of childhood health’s contribution to the reproduction of social inequality.

In this chapter, I use data from the Panel Study on Income Dynamics (PSID) to investigate whether child health (as measured by low birth weight) has remained strongly associated with adult educational attainment across 1940-1985 birth cohorts. I pay attention to
cohort trends at key educational transitions (from less than high school to high school completion, from high school completion to any postsecondary education, and from any postsecondary education to college graduation) and examine variation in trends by sociodemographic characteristics. In particular, I ask three broad questions: (1) Across birth cohorts, has the penalty that low birth weight exerts on individuals’ educational attainment changed? (2) If so, at which educational transitions has cohort change occurred? and (3) Do cohort trends vary by sex and race? As I describe below, an examination of sex and race differences in trends offers some leverage in understanding what may have propelled observed patterns.

BACKGROUND

Prior research demonstrates that low birth weight (defined as weighing less than 2,500 grams or about 5.5 pounds) has educational consequences throughout an individual’s life course (Jackson 2009). Estimates of low birth weight (LBW)’s educational consequences vary across studies and child health measures, but most evidence indicates that they are strong. For example, Conley and Bennett (2000) find that LBW individuals are 44 to 87 percent less likely to complete high school compared to their healthy birth-weight peers. As LBW rates are higher among socioeconomically disadvantaged children (Mathews and MacDorman 2007), these longer-term educational consequences mean that LBW is likely an important driver of the intergenerational reproduction of disadvantage (Conley, Strully, and Bennett 2003a).

Explanations for birth weight’s long arm

Prior research demonstrates that the association between LBW and educational attainment is likely causal (Black, Devereux, and Salvanes 2005; Conley and Bennett 2000,
Because of poor in utero conditions (Barker 2005; McDade 2005), LBW children face reduced cognitive skill formation and/or experience worse health throughout their lives compared to healthy birth-weight children (Blanden, Gregg, and Macmillan 2007; Boardman et al. 2002; Currie 2009; Haas and Fosse 2008; Palloni 2006). For example, LBW children tend to earn lower scores on development tests of cognitive skills (Brooks-Gunn, Keblov, and Duncan 1996) and tend to have more illnesses throughout their childhood (Gross, Spiker, Haynes 1997; McCormick, Shapiro, and Starfield 1980) compared to those who were heavier at birth.

Poor cognitive development and poor later childhood health, in turn, influence educational attainment. Sicker children tend to be absent from school more often than healthier children, which impedes educational attainment (Grossman and Kaestner 1997). Students with reduced cognitive skills resulting from poor early-life health perform worse academically than their healthy weight counterparts (Boardman et al. 2002). LBW students’ impaired academic

---

It is difficult to estimate the share of the observed association that is causal. Research that uses family-fixed effects to isolate the contribution of home environments and genetics (both of which siblings share) from LBW itself provide mixed evidence. Almond and colleagues (2005) find that family characteristics—not birth weight itself—explains up to 95 percent the association between LBW and later life outcomes, whereas Behrman and Rosenweig (2004) find that LBW’s causal effect is underestimated by ordinary least squares (OLS) models. They report that the causal effect of LBW can be up to twice as large as the "total association" estimated by OLS regression.

However, family-fixed effects models problematically assume that all siblings experience similar parenting, regardless of birth weight. But there is evidence that mothers invest differently in their LBW and healthy birth-weight children. Hsin (2012) finds that college-educated mothers “compensate” for early-life disadvantage by spending more time with them than their healthy weight children, but less-educated mothers disproportionately spend time with their healthy weight children.

Academic achievement difficulty and school absence are also part of feedback processes in which they are causes and consequences of reduced cognitive skill formation. For example, lower cognitive skills might prevent a student from engaging in academic material. Non-engagement might prevent additional cognitive skill development, thereby accumulating additional disadvantage throughout a child’s time in school.
participation and performance contribute to their lower educational attainment (Jackson 2009). Thus previous research provides evidence consistent with LBW causing reduced educational attainment.\(^{21}\)

**Has the association between LBW and educational attainment changed across birth cohorts?**

Prior research indicates that socioeconomic disparities in birth weight have narrowed across the twentieth century (Aizer and Currie 2014; Mathews et al. 2000; Mathews and MacDorman 2007). Earlier dissertation chapters demonstrate that maternal education gradients in child health have weakened across birth cohorts. These findings join a number of other studies that document declining socioeconomic gaps and the declining effect of socioeconomic status in child health overall and in LBW in particular (Aizer and Currie 2014; Currie, Decker, and Lin 2008; Mathews and MacDorman 2007). But no studies to my knowledge have examined trends in the later-life consequences of child health, including of birth weight. What are the longer-term implications of diminishing early-life health inequalities?

On one hand, as I hypothesize below, the educational consequences of LBW might have diminished across cohorts (or remained stable). In tandem with the weakening relationship between parental SES and LBW, this pattern would indicate that role of health in intergenerational cycles of disadvantage has dramatically diminished over the twentieth century.

On the other hand, the educational consequences of LBW could have strengthened due to improved survival among the sickest infants who would have died in earlier years. Particularly poor health and large cognitive deficits make these children less likely to accrue schooling than LBW infants born earlier in the twentieth century. Stronger educational penalties across birth cohorts, in turn, could offset some of the declining relationship between parental SES and LBW.\(^{21}\)

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\(^{21}\) Although the association is not fully causal, I adopt causal language for ease of exposition.
Even though parental socioeconomic circumstances have become weaker determinants of birth weight over twentieth-century birth cohorts, children of less-educated mothers are still less healthy than children of educated mothers. Stronger educational consequences of LBW, then, would mean that child health remains a major channel for the transmission of disadvantage across generations. Therefore, my analyses add to our understanding of whether child health has become more or less important for the reproduction of social inequality across twentieth-century birth cohorts.

In the next few sections, I review a number of macrosocial patterns that have expanded educational opportunities and improved prenatal and perinatal health. I then describe their implications for the association between child health and educational attainment across birth cohorts. Overall, I hypothesize that the educational consequences of LBW have weakened across mid-twentieth-century birth cohorts. The expansion of educational opportunities during the mid-twentieth century may have weakened the association between LBW and educational attainment across birth years. But the influence of medical advances and improved pre- and neo-natal health on LBW’s educational consequences is indeterminate.

**Changing production of health**

Across twentieth-century cohorts, children’s *in utero* environments improved due to reduced exposure to infectious disease and improved access to nutrition (Case and Paxson 2010; Fogel 2004; Rashad 2008). For example, the introduction of nutritional assistance programs, such as the Supplemental Nutritional Assistance Program (SNAP) (introduced in 1964), the Supplemental Feeding Program for Women, Infants, and Children (WIC) (introduced in 1972), and the Infant Health and Development Program (IHDP) (introduced in 1985) improved the
health of children and pregnant mothers across birth cohorts (Currie 2007; Kreider et al. 2012; Rank and Hirschl 2009).

These nutrition policies, the emergence of preferences for reduced fertility and for spaced births, and the decline in maternal smoking have improved the health of American babies across the twentieth century (Aizer and Currie 2014; Child Trends Databank 2015; Kessel et al. 1984; Lee et al. 1980). Although the incidence of LBW births was relatively stable between 1940 and the early 1970s (Lee et al. 1980), marked improvements occurred in the next decade. In 1970, about 7.4 percent of births in the United States were LBW, but by 1980, only about 6.3 percent of births were below the LBW threshold (Kessel et al. 1984). Once born, LBW prospects improved: medical advances over the course of the twentieth century substantially reduced infant mortality rates among LBW children across twentieth-century birth cohorts (Paneth 1995).

These advances have mixed implications for cohort trends in the association between LBW and reduced educational attainment. On one hand, improved in utero nutrition through social welfare programs and medical advances may have strengthened LBW’s educational penalties. Children who are born LBW despite having proper nutrition and prenatal care might be sicker than LBW children born before these programs were introduced. Infants who remain LBW may have more severe health issues that contributed to their LBW status or may have mothers who did not take advantage of the programs and/or who smoked. Similarly, medical advances (especially during the 1980s) improved the survival prospects of babies who would have died in earlier years (Horbar et al. 2002; Singh and Yu 1995). Due to their precarious health, these babies would likely experience greater cognitive and medical difficulties throughout childhood than LBW children born in earlier decades.
In other words, because of improved nutrition and better infant survival, LBW status might have become a stronger marker of cognitive and health disadvantage across birth cohorts. That means improvements in prenatal and early-life medical interventions imply a stronger association between LBW and educational attainment across cohorts. On average, LBW would present more educational barriers for children born in the 1980s than for LBW children born before the advent of these medical advances.

On the other hand, improved postnatal care of preterm and underweight babies (via medical intervention and/or assistance to families) may have buffered the physiological consequences of LBW and ensured normal patterns of cognitive development. For example, evidence from Denmark finds declines in the disability and hospitalization consequences of LBW (Maruyama and Heinesen 2013). Assuming that these improvements also occurred in the American context, these medical advances imply that the association between LBW and educational attainment may have weakened across twentieth-century birth cohorts.

Therefore, it is difficult to predict the direction of change across cohorts in the educational consequences of LBW based on the declines in the percentage of children who are LBW, increased infant survival, and medical advances in pre- and post-natal care. Across cohorts, medical improvements may have concentrated impaired children into the LBW category, but may have also helped to reduce some of LBW’s negative consequences (e.g., cognitive deficits) believed to impede educational attainment.

Overall changing production of education

Changes in the production of education may have also reshaped the association between child health and lower educational attainment across twentieth-century birth cohorts. Educational attainment rose across birth cohorts. Whereas about 40 percent of Americans born in the 1910s
graduated from high school, more than 80 percent born in the early 1980s did. During the middle part of the century, individuals attained more schooling in part due to the rapid expansion in two- and four-year colleges beginning in the 1960s (Mare 1995; Snyder and Dillow 2013). The percentage of persons obtaining at least a bachelor’s degree ballooned from about 6 percent to 33 percent over the same birth years (Snyder and Dillow 2013).

Prior studies find that educational mobility relative to parental educational attainment has increased across twentieth-century birth cohorts (Breen 2010; Hout 2012; Pfeffer and Hertel 2015). Only the most socioeconomically and health-advantaged individuals born in the first several decades of the twentieth century could graduate from high school and continue to postsecondary schools. However, as college enrollment opportunities increased, less privileged children increasingly were able to obtain a diploma and enter postsecondary education (Breen 2010; Hout 2012).

Therefore, prevailing education trends suggest that LBW’s educational consequences may have diminished across mid-twentieth-century birth cohorts. I hypothesize that LBW children are among the disadvantaged persons who have been able to take disproportionate advantage of educational expansion during the later half of the twentieth century.

Where in the educational attainment process has changed occurred?

Focusing only on total educational attainment might obscure cohort trends in birth weight’s educational consequences if LBW’s educational consequences have not changed uniformly across all levels of education. One way to assess where in the educational attainment process LBW’s educational consequences may have weakened or strengthened is to focus on transitions between levels of schooling. Mare (1981) argues that individuals decide whether to attain higher levels of education at a series of key transitions. After completing high school, for
example, teenagers decide whether to continue with postsecondary schooling or to enter the labor force.

Prior research has demonstrated that LBW’s average (cross-sectional) association with education varies across key decision points, such whether to complete high school or to continue on to college. For example, Johnson and Schoeni (2007) estimate that LBW children face a one-third higher dropout rate compared to healthy birth-weight Americans but face only modest reductions in total educational attainment (about one-third of a year of schooling) compared to their counterparts with better early-life health. Examining trends at each education transition, therefore, might help to reveal cohort variation obscured by a summary attainment measure.

Cohort trends in the educational consequences of LBW might also differ at various levels of schooling. During the latter part of the twentieth century, individuals from disadvantaged families have increased their educational attainment by graduating from high school and/or attending two-year institutions. In contrast, those from more-advantaged origins tend to attend four-year colleges (Davies and Guppy 1997; Lucas 2001; Karen 2002). One theoretical perspective, maximally maintained inequality (MMI), contends that the importance of family background and early-life circumstance declines at transitions (e.g., from high school to postsecondary education) only insofar as they become universal (Hout, Rafferty, and Bell 1993). Inequalities in postsecondary education and other levels that have not become universally attained (e.g., graduation from four-year colleges) persist across time and birth cohorts. Once higher education becomes universally attained among advantaged groups, then (and only then) will continued education expansion at the postsecondary level include those from disadvantaged backgrounds. Indeed, while family background has become a weaker predictor for educational
attainment overall (Breen 2010), it remains a durable predictor for college graduation (Ellwood and Jencks 2004).

Additionally, a number of policies were introduced for high school students—but not for college students—that might have weakened the educational consequences of LBW. For example, legislation introduced in 1975 (“Education for All Handicapped Children Act”) started special education programs to aid cognitively and health-disadvantaged children. Such programs likely have weakened the association between LBW and high school completion but likely have no effect on the association between LBW and postsecondary outcomes.

Therefore, I predict that cohort declines in the association between LBW and lower educational attainment were largely limited to LBW’s influence on high school completion. Over cohorts, I expect the relationship between LBW and reduced high school completion to have diminished. However, as college attendance at four-year institutions became increasingly common in the latter part of the twentieth century (particularly among more elite Americans), LBW’s consequences for attaining any postsecondary education might have also decreased. But enrollment at the postsecondary level occurred later and more slowly, which means that we should observe later cohort declines in LBW’s influence on postsecondary education than for cohort declines in LBW’s influence on high school graduation. Because college completion had not become universal among more-advantaged groups by 1980s birth cohorts, I expect birth weight barriers for college graduation to persist.

Do cohort trends vary by sex and race?

My primary aim in this chapter is to offer a description of whether the relationship between LBW and reduced educational attainment has weakened across birth cohorts. I am unable to offer a direct test of which societal improvements may account for any observed cohort
trends. As I describe below, asking a third research question, namely whether cohort trends vary by sex and race, can provide some leverage in understanding if both educational expansion and health improvements have contributed to the changing educational consequences of LBW.

Expanded educational opportunities suggest that women will have experienced greater decreases in the educational consequences of LBW than men across birth cohorts. Although educational attainment has risen for both sexes, prior research has shown larger increases for women than for men across the twentieth century (Buchmann and DiPrete 2006; Mare 1995, 1997; Snyder and Dillow 2013). Indeed, by the 1980s, women began to constitute a majority of college graduates. Yet in contrast to sex differences in education, there is no reason to expect that medical advances have disproportionately benefited female babies. Thus stronger declines in LBW’s educational consequences for females than for males should be largely attributable to changing education patterns, not to changing health patterns.

However, black-white differences in student achievement (Reardon 2011) and high school completion (Mare 1995) have narrowed across the twentieth century. Some research even finds that increased educational mobility across the twentieth century has mainly been concentrated among blacks. For example, Bloome and Western (2011) find that, between 1966 and 1979, parental education became only slightly (if at all) less predictive of son’s educational attainment for white Americans, but it became substantially less predictive of son’s educational attainment for black Americans. To the extent that changing educational patterns (not changing health patterns) affect the relationship between LBW and educational attainment, we should see larger decreases in the effect of LBW on educational attainment over cohorts for blacks than for whites.
These educational gains notwithstanding, black American babies have continued to fare worse than their white counterparts in terms of health. Black-white gaps in birth weight and infant mortality have persisted and widened across the latter half of the twentieth century (Kleinman and Kessel 1987; Smedley, Stith, and Nelson 2003). Thus if changing health patterns have modified the relationship between LBW and educational attainment over cohorts, we should see weaker cohort declines for blacks than for whites. Educational trends (which drive the association in the opposite direction) mean we might not see any differences in cohort trends between blacks and whites.

To summarize: to the extent that education patterns drive part of the association between LBW and reduced educational attainment, I predict that women and blacks have experienced larger declines in LBW’s educational consequences across twentieth century cohorts than men and whites, respectively. To the extent that health patterns drive part of the association between LBW and reduced educational attainment, I predict whites have experienced larger declines in LBW’s educational consequences across twentieth century cohorts than blacks. To the extent that both health and education patterns drive the trend, I predict blacks and whites have experienced similar decreases in LBW’s educational consequences across both cohorts.

**Current study**

The analyses below extend our understanding of the lasting educational consequences of LBW and investigate variation across 1940 -1985 birth cohorts. Through them, I describe cohort trends in LBW’s association with total educational attainment and likelihood of making key education transitions. As argued above, I predict that educational expansion and improved health weakened the education consequences of LBW, but mainly for high school graduation and transitions into any postsecondary education. I also hypothesize that trends vary by sex and race,
but the direction of influence depends on the contribution of education expansion and health advances to cohort trends in the educational consequences of LBW. Similar to other research examining the relationship between health and socioeconomic advantage (e.g., Warren and Hernandez 2012), my analyses should be considered descriptive evidence for whether cohort trends exist. Evidence as to why they may exist (through the sex- and race-stratified analyses) should be considered suggestive.

**DATA AND METHODS**

Analyses use data from the Panel Study of Income Dynamics (PSID). Beginning with a probability sample of American families in 1968, the PSID has followed a cohort of respondents as well as their biological or adopted descendants (those tagged with the so-called “PSID gene”) and their families. Prior to 1997, the PSID interviewed respondents annually; in 1997, the PSID switched to biannual interviews. Respondents report information about their social, demographic, and health characteristics at each wave.

I restrict my sample to individuals who participated in at least one wave between 1999 and 2011 to obtain comparable information about their educational attainment, family background, and early-life health history. I also limit analyses to respondents who were at least 25 years old at the time of interview and who have complete information about their birth weight and educational attainment. This restriction strategy leaves 5,932 individuals born between 1940 and 1985.

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22 For additional detail about the PSID’s design, see http://psidonline.isr.umich.edu
23 As some individuals (particularly in younger cohorts) might not finish schooling by age 25, I estimate additional models in which I examine an individual’s schooling at age 30 and age 35. These additional models produce similar estimates of cohort trends; therefore, I do not present them and instead show estimates from the widest range of PSID birth cohorts.
Measures

**Birth weight.** I capture birth weight through a dichotomous measure that indicates whether a respondent weighed under 2,500 grams (or about 5.5 pounds) at birth. For children born before 1986, parents were only asked whether the child was born LBW (weighing under 2500 grams). Although information about birth weight is collected retrospectively, retrospective LBW measures are both valid and reliable (Klebanoff and Graubard 1986; Walton et al. 2000). A continuous measure of birth weight is available for children born in 1987 and later, but these respondents are still too young at the most recent wave to assess educational attainment.

**Educational attainment.** My main analyses focus on LBW’s association with educational attainment. I assume that individuals complete their schooling by age 25. The PSID collects educational attainment information in one-year intervals, and top-codes attainment at 17 years of schooling. Due to a limited sample size and PSID question design, I include individuals who earn a GED as high school graduates. Sensitivity checks among a subsample of the PSID sample for whom I can tease apart GED-earners from other high school graduates offer findings similar to the ones presented in this paper.

My initial models focus on total educational attainment, i.e. the highest level of attained schooling. Additional models (described below) examine educational attainment at key transitions by dividing the total sample into four levels: < 12 years of schooling, 12 years, 13-15 years, and 16+ years.

**Family background.** Family background predicts both birth weight (Currie 2011) and a child’s educational attainment (Ellwood and Jencks 2004; Mare 1995). For example, socioeconomically advantaged mothers are less likely to have LBW babies than disadvantaged mothers (Conley, Strully, and Bennett 2003a) because they are less likely to experience
proximate causes of LBW, such as stress, anxiety, high blood pressure, physical labor, under-
nutrition, and infectious disease exposure than poorer and less-educated mothers (Allen and 
are also more likely to graduate from high school and attend college than those from humbler 
backgrounds (Blau and Duncan 1967; Bloome and Western 2011), irrespective of birth weight. 

Therefore, models include measures of parental schooling, paternal occupation, and 
number of siblings, as family background influences both birth weight and educational 
attainment. Maternal and paternal education are measured continuously,²⁴ and I measure paternal 
occupation through a measure of occupational prestige (Hauser and Warren 1997). This index is 
a function of the number of persons within a given Census occupation category who hold at least 
a college degree, and is used by other research looking at child health’s educational 
consequences (e.g., Haas 2006). Adopting the strategy of prior work (e.g., Conley and Bennett 
2000; Haas 2006), I also include indicators of whether information on paternal education, 
maternal education, and/or paternal occupational prestige is missing.

I also examine three aspects of family configuration: parental marital status at an 
individual’s birth, maternal age, and sibship size. An indicator variable captures whether 
respondents’ parents were married at the time of birth (married, not married). To calculate a 
mother’s age, I subtract a respondent’s year of birth from his mother’s year of birth. I then 
transform this linear measure into two indicator variables: whether a mother was less than 25 
years old at the time of her child’s birth and whether she was at least 35 years of age. Maternal 
age influences life chances in a non-linear manner; children born to older and younger mothers 
face socioeconomic, early-life health, and educational trajectories that differ from those of

²⁴ I use as a continuous measure because it substantially improves model fit (as measured by a 
smaller BIC) compared to indicator variables for maternal schooling (<12 years (ref.), 12 years, 
13-15 years, 16+ years). My results are not sensitive to the measure’s parameterization.
children born to 25-34 year olds (Blake 1989; Downey 1995, 2001; Myrskylä and Fenelon 2012; Ragozin et al. 1984). I measure each respondent’s number of siblings linearly (0 siblings, …, 6 siblings).

I adjust for other characteristics related to both birth weight and education attainment. These additional covariates include a respondent’s race (white, nonwhite) and sex (male, female). I also include a binary indicator if an individual was the first born to a mother, as first births have higher probabilities of being LBW (Miller 1994; Conley and Bennett 2000).

**Analytic Strategy**

In order to assess whether the association between LBW and total educational attainment has changed across birth cohorts, I first estimate a model of the following form via ordinary least squares (OLS) regression:

\[
Edu = \beta_0 + \beta_1 \text{LBW} + \sum_{k=2}^{9} \beta_k \text{Cohort} + \sum_{j=10}^{13} \beta_j \text{Cohort} \times \text{LBW} + \eta_k X + \epsilon
\]  

Where $Edu$ is a measure of educational attainment in years (from 0 to 17 years), $\text{LBW}$ is a dichotomous indicator of whether a child weighed under 2,500 grams at birth, $\text{Cohort}$ is a child’s birth year measured in decade-wide intervals, and $X$ is a vector of covariates (described above). I also re-estimate models with a linear measure of cohort and with 15-year-wide cohort indicators (not shown) and find similar results.\(^\text{25}\)

The main coefficients of interest are those on the interaction between cohort and LBW.

Importantly, as birth weight negatively influences educational attainment (i.e. prior literature

\(^{25}\) I also estimated models (similar to those estimated by Duncan et al. 2013) in which I allowed family background to vary across cohort by including interactions between cohort indicators and each family background variable (maternal education, paternal education, paternal occupational prestige, sibship size, mother’s age at birth, and parental marital status at birth). These additional terms were introduced to account for the changing distribution of these characteristics across cohort. Accounting for these changes through 40 additional interaction terms does not substantially affect point estimates (but substantially inflates standard errors). Therefore, I present the more parsimonious model.
indicates that $\hat{B}_1 < 0$), a negative coefficient on the LBW-by-cohort interactions (e.g., $\hat{B}_{10} < 0$, $\hat{B}_{11} < 0$, etc.) suggests that LBW’s educational consequences strengthened across birth cohorts, whereas a positive coefficient suggests that those consequences weakened.

These models assess whether LBW continues to be as strongly associated with total educational attainment across birth cohorts. However, decisions about educational attainment occur at key transitions (Mare 1981). I also estimate a series of dichotomous education transitions models (Mare 1981, 2006; Breen and Johnson 2006; Buis 201). Although most research estimates these models via logistic regression, I use linear probability models to allow clearer comparisons across models. Specifically, I estimate:

$$E_{HS} = \alpha_0 + \alpha_1 \text{LBW} + \sum_{k=2}^{9} \alpha_k \text{Cohort} + \sum_{i=10}^{13} \alpha_k \text{Cohort} \times \text{LBW} + \tau_k X + e$$  \hspace{1cm} (4.2)

$$E_{PS} | (E_{HS} = 1) = \delta_0 + \delta_1 \text{LBW} + \sum_{k=2}^{9} \delta_k \text{Cohort} + \sum_{i=10}^{13} \delta_k \text{Cohort} \times \text{LBW} + \pi_k X + e$$  \hspace{1cm} (4.3)

$$E_{C} | (E_{PS} = 1) = \gamma_0 + \gamma_1 \text{LBW} + \sum_{k=2}^{9} \gamma_k \text{Cohort} + \sum_{i=10}^{13} \gamma_k \text{Cohort} \times \text{LBW} + \sigma_k X + e$$  \hspace{1cm} (4.4)

Where $E_{HS}$, $E_{PS}$, and $E_{C}$ are indicators for whether an individual completes high school, completes any postsecondary education, and graduates from college, respectively. All other terms are the same as in Equation 4.1.

As Equations 4.2-4.4 indicate, this approach assumes that individuals must pass through an earlier transition before deciding whether to attain more schooling. Only individuals who complete high school, for example, can decide whether to attend college. Appendix Figure 4.A1 depicts this decision-making process. I first model cohort trends in LBW’s influence on an individual’s probability of graduating from high school relative to dropping out (Equation 4.2). I

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26 These models also offer a methodological advantage: Estimates of schooling attained are sensitive to changes in the distribution of educational attainment, particularly with an increasingly top-heavy distribution (Mare 1980; Bloome and Western 2011).

27 Results estimated via linear probability models (OLS) and logistic regression are substantively identical.
then estimate cohort trends in LBW’s influence on an individual’s probability of accruing any postsecondary education among high school graduates (Equation 4.3). Finally, I estimate cohort trends in LBW’s influence on (four-year) college graduation prospects among those who complete any postsecondary schooling (Equation 4.4). As a robustness check, I also re-estimate the final transition to examine college graduation prospects among all high school graduates and among the entire sample. These additional models yield estimates substantively identical to the ones presented.

Missing data and sample weights. I handle missing data via listwise deletion, except for missing data on parental education and paternal occupational prestige (which I address through indicators for missingness).28 Only a small percentage of the sample with birth-weight information is missing information on other covariates (about 4.5 percent). All analyses are unweighted; however, sample weights do not appreciably alter most substantive conclusions.

RESULTS

Sample characteristics

Table 4.1 presents descriptive characteristics of the PSID sample stratified by birth-weight status. Individuals born weighing less than 2,500 grams (or about 5.5 pounds) at the time of birth constitute about 7.5 percent of the PSID sample, which is about the same percentage as in previous research (e.g., Conley and Bennett 2000). Most sample characteristics differ by LBW status. Consistent with prior literature, LBW individuals attained slightly less education than healthy birth-weight individuals. They completed about 12.1 years of education (s.d. 2.3 years) compared to 12.4 years (s.d. 2.3 years) for individuals with better early-life health. LBW

28 Given the large amount of missing data for paternal occupational prestige, I also re-estimated model without this variable. Excluding the information about parental occupation does not affect results.
individuals also were disadvantaged with respect to nearly all other sample characteristics that also influence educational attainment: LBW individuals tended to have less-educated parents, fathers with lower occupational prestige scores, more siblings, and unmarried parents at the time of their birth. As these family characteristics influence both birth weight and educational attainment, these findings highlight the importance of adjusting for family background differences in multivariate models.

Has the association between birth weight and total educational attainment changed across cohorts?

[Table 4.2 about here]

Before turning to my first research question concerning whether there is any evidence of change in the association between birth weight and total educational attainment across birth cohorts, I first replicate existing cross-sectional research and regress the highest year of completed schooling on birth weight and covariates. Here (Table 4.2, Column 1), we see the same basic relationship between LBW and educational attainment documented in prior work (e.g., Black et al. 2005; Conley and Bennett 2000). LBW children tended to compete slightly less education—about 0.22 years less education—than children born weighing at least 2,500 grams. The magnitude of this difference is similar to estimates from prior research.

But does this relationship vary across birth cohorts? Medical advances and educational expansion largely lead me to predict that LBW’s educational penalties will have weakened across 1940s to 1980s birth cohorts. Results support this hypothesis. In Column 2, I allow the educational attainment consequences of LBW to vary by when individuals were born. Consistent with hypotheses, statistically significant interactions between LBW and each of the cohort indicators suggests that the educational consequences of LBW substantially weakened across
1940 and 1985 birth cohorts. LBW children born in 1940 (the reference year) tended to accrue almost a year and half less schooling (1.42 years) than their contemporaries who were born at a healthy weight. But this penalty weakened by about a year of education for children born only a decade later, with additional decreases in subsequent birth cohorts.

[Figure 4.1 about here]

To offer a sense of the magnitude of these cohort declines, I plot the estimated effect of LBW for children born in the 1940s through the 1980s (Figure 4.1). Here, there is clear evidence for weakening educational consequences of LBW. Only LBW children born in the 1940s and 1950s tended to complete less schooling than healthy birth weight children. LBW was not predictive of total educational attainment for respondents born in any of the next three decades. Thus, not only has parental educational attainment become less predictive of children’s early-life health across cohorts (e.g., previous chapters, Aizer and Currie 2014), but at least one aspect of early-life health, namely LBW, no longer influences educational attainment in recent birth cohorts.

Where in the educational attainment process has changed occurred?

The estimates presented thus far concern total educational attainment. However, students make decisions about educational attainment at key transitions (Mare 1981). For example, students decide whether to continue on to a postsecondary education—that is, whether to attain more than 12 years of schooling—only if they complete high school. Differences in educational attainment, therefore, are produced at these junctures.

It is unlikely that LBW now exerts a weaker penalty at all levels of schooling. One theoretical perspective, namely maximally maintained inequality (MMI) (Hout, Rafferty, and Bell 1993) suggests that declines in LBW’s educational consequences may be limited to lower
levels of education (e.g., high school graduation prospects). Higher levels of education have not become fully universal among society’s advantaged members; therefore, underprivileged groups—including those with early-life health disadvantage—might still face more educational barriers at higher levels of schooling than those with better early-life health. I hypothesize that declines in the association between LBW and high school graduation will mainly drive the weakening influence of LBW on educational attainment described above. Although we might also see declines in the postsecondary-education consequences of LBW across cohorts, I predict these declines will be smaller and/or occur after declines for high-school-completion consequences.

[Table 4.3 about here and Figure 4.2]

Table 4.3 presents estimates from nested sequential linear probability models that take into account educational transitions. Column 1 presents results for cohort trends in LBW individuals’ likelihood of completing high school. As with the association between LBW and total education, there is a general weakening relationship between LBW and high school completion across cohorts. Although LBW reduced the likelihood of graduating high school by 16.2 percent for PSID respondents born in 1940 compared to higher birth weights, this penalty did not persist in later birth cohorts. Indeed, the left panel of Figure 4.2 shows that LBW did not influence high school completion prospects for individuals born in 1950-1985.

Yet the cohort declines in the educational consequences of LBW follow different trajectories for high school completion than for total educational attainment. First, LBW promoted high school graduation for children born in the 1940s. However, there is no conceptual reason to imagine a positive association between LBW and high school completion prospects for students who were born between 1970 and 1979 and graduated high school between in the late
1980s through the 1990s. For example, policy efforts, such as high school special education programs, would have affected a wider range of cohorts. Moreover, PSID data do not allow me to explore other possibilities in the present analysis.

Second, LBW’s high school graduation penalty disappeared a decade before the total educational attainment penalty did (1950s birth cohorts versus 1960s birth cohorts). There are also no differences in the high school completion consequences of LBW for 1950s and 1960s birth cohorts. This finding is consistent with my MMI-based hypotheses, as this pattern is consistent with the achieved near-universality of high school graduation by the 1970s (when 1950s birth cohorts would complete secondary education).

Educational expansion patterns also suggest that we might see decreases in LBW’s consequences across cohorts for the transition from high school to postsecondary education. The increased number of enrollment spots at two-year colleges offered new educational opportunities for less-advantaged individuals, while new spots at four-year colleges allowed more-advantaged individuals to accrue more schooling and maintain their advantage. However, these cohort declines might be more modest and/or later than declines for high school completion. As suggested by the theoretical perspective of MMI, in the 1970s (when children born in the 1950s would enter college), college was still not universally attained even among the most-advantaged members of society.

The middle column of Table 4.3 and the middle panel of Figure 4.2 examine the influence of LBW on completing any postsecondary education (i.e. at least 13 years of schooling) among those who completed high school. Here, I find mixed evidence for my hypotheses. On one hand, as expected, the cohort decline in LBW’s penalty on postsecondary education occurred later than the decline for its penalty on high school completion. LBW
respondents born in the 1950s, for example, were as likely as healthy birth-weight children to
graduate from high school but were 12.5 percent less likely than health birth-weight children to
complete any postsecondary education (i.e., to attain at least 13 years of education).

On the other hand, an examination of the plot in Figure 4.2 reveals a peculiar finding for
the most recent cohort (children born between 1980 and 1985). Despite no association between
LBW and postsecondary education for children born in the 1960s and 1970s, LBW impeded
postsecondary education prospects for children born in the 1980s. This finding might reflect a
reversal of the declining importance of LBW for postsecondary attainments. Advances in
prenatal care and obstetric interventions substantially improved preterm survival beginning in the
1980s, reducing premature death and allowing more children to survive to adulthood (Child
Trends Databank 2015; Demissie et al. 2001). LBW children born in the 1980s might have been
sicker than LBW babies born in prior decades. Therefore, LBW might impose barriers to higher
education that had not been present for children in the previous two decades. Indeed, although
not statistically significant, there is some evidence of this reversal for the 1980s birth cohort in
the association between LBW and total educational attainment (Figure 4.1).

Finally, I examine the influence of LBW on college completion prospects among those
who complete any postsecondary schooling (Table 4.3, Column 3 and Figure 4.2, right panel).
Birth weight was not associated with an individual’s likelihood of graduation among those who
completed high school and began postsecondary schooling for any cohort. I fail to find any
influence of LBW on college completion. Tests of the joint-significance of the LBW term and
the weight-by-cohort interaction also indicate that there was no significant association between
birth weight and college graduation prospects.
The number of hurdles LBW children had to overcome to reach higher levels of schooling might explain this finding. LBW children who had been able to graduate high school and attain some postsecondary education likely had fewer cognitive and health deficits than LBW children who were not able to complete lower levels of schooling. They also may have had more socioeconomic advantages than their peers that might allow them to overcome their early-life health disadvantage. Because there is no relationship between LBW and college graduation, this finding neither supports nor undermines my hypotheses concerning cohort trends in LBW’s consequences for college completion.

**Do cohort trends vary by sex and race?**

To offer some suggestive evidence as whether the health and education patterns described above contribute to the observed cohort declines in LBW’s educational consequences, I examine whether cohort trends vary by sex and race. Twentieth-century educational expansion benefited women more than men and blacks more than whites. But health improvements benefited whites more than blacks (and affected both sexes equally). Therefore, examining these demographic groups separately shows if there is at least some validity to the claim that both education and health patterns have driven the weakening of the association between LBW and educational attainment. Due to sample size limitations, I measure cohort continuously (in five-year increments) rather than with separate indicators.\(^{29}\) I also exclude 158 respondents who identified as neither black nor white.\(^{30}\) Table 4.4 presents estimates from these additional models.

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\(^{29}\) A comparison of linear cohort trends and separate cohort indicators for the full models (i.e. those presented in Tables 4.2 and 4.3) suggests that a linear trend provides a reasonably comparable fit. However, a linear specification tends to underestimate LBW’s educational consequences for individuals born in the 1950s and incorrectly suggests that LBW promotes educational attainment for individuals born after 1980.

\(^{30}\) Results are similar regardless if I stratify the sample to examine black-white differences or nonwhite-white differences in cohort trends.
Results broadly indicate that both health advances and educational expansion could have contributed to the trends described earlier. Specifically, Table 4.4 shows that LBW only influences the educational attainment of women. LBW women born in 1940 (the reference year) attained less total education than healthy birth-weight women, but LBW men did not attain significantly less education than healthy birth-weight men. This disparity is also found in some other research, which finds only weak effects of early-life health on men’s educational attainment (Cuhna et al. 2010).

As expected, given the main effect of LBW, cohort declines in the relationship between LBW and total attainment occurred only for women. In more recent cohorts, women (but not men) experienced less of a reduction to their educational attainment due to LBW than did women born in earlier cohorts. This finding is consistent with existing evidence that women disproportionately benefitted from mid-twentieth century educational expansion (Buchmann and Diprete 2009; Goldin 2006) and implies that education-related patterns could drive at least part of the observed cohort declines in the educational consequences of LBW. However, the lack of any cross-sectional relationship between LBW and educational attainment for men limits the strength of the conclusions we can draw.

Race-specific analyses suggest that declines in low birth weight’s consequences for total educational attainment across twentieth century birth cohorts occurred to comparable degrees in both white and black populations. LBW lowers educational attainment by about .64 years for whites and .69 years for blacks, but this difference is not statistically significant. Whites and blacks also experience similar decreases in the educational consequences of LBW across cohorts: the effect of LBW is reduced by .14 years of schooling for every five birth years for both racial groups.
This finding might be due to offsetting influences. As noted earlier, racial gaps in student achievement (Reardon 2011) and high school completion (Mare 1995) have narrowed because black educational attainment rose faster than white educational attainment (Hauser 1993). However, black-white gaps in birth weight persisted because prenatal interventions and technologies lowered white LBW and infant mortality rates faster than black LBW and infant mortality rates (Kleinman and Kessel 1987). Therefore, we cannot rule out twentieth-century improvements in health or education as potential candidates for explaining the observed cohort declines in LBW’s “long arm.”

**DISCUSSION AND CONCLUSION**

My analyses extend earlier work that has established a robust association between LBW and educational attainment (Black, Devereux, and Salvanes 2005; Conley and Bennett 2000, 2001; Conley, Bennett, and Strully 2003a, 2003b; Johnson and Schoeni 2007; Royer 2009). I build upon a cross-sectional snapshot to examine whether the association between LBW and educational attainment changed across 1940 to 1985 birth cohorts. Across the mid-twentieth century, poor “starting gate” health (Conley, Strully, and Bennett 2003a) became a substantially weaker predictor of later life health. In fact, LBW was no longer associated with reduced educational attainment starting for 1960s birth cohorts.

Estimates at key education transitions indicate that decreases mainly occurred as a result of a weakened influence of LBW for lower levels of educational attainment across cohorts, namely for high school graduation and for continuation onto any post-secondary schooling. The influence of LBW on high school graduation permanently disappeared across cohorts, starting with 1950s birth cohorts. Although LBW no longer impaired high school completion prospects by 1960s birth cohorts, this progress reversed for PSID respondents born in the 1980s. Although
I am unable to test why this reversal occurred, it is consistent with 1980s pre- and peri-natal medical advances that allowed for the survival of impaired babies. Perhaps counterintuitively, the reemergence of LBW’s education consequences, therefore, reflects societal improvement in children’s state of wellbeing, i.e., a reduction in premature death, across cohorts.

Taken together, these results offer support for my hypothesis that LBW individuals were among the groups that historically experienced educational disadvantage who benefited from educational expansion in the twentieth century. Expanded educational opportunities mainly benefited individuals’ prospects of graduating from college and attending two-year schools (Alon 2009; Snyder and Dillow 2013). As more advantaged children enrolled in college, high school completion became nearly universal among the healthiest and wealthiest members of society. This universality allowed less advantaged individuals—including LBW individuals—to attain more education.

**Health and education**

I have argued that education- and health-related improvements drive the shortening “long arm” of early-life health. I cannot tease apart the relative contributions of each. However, together my results suggest that both might be important for understanding the declining importance of child health for educational attainment. For example, sex-stratified results suggest that decreases in the relationship between LBW and educational attainment were almost exclusively limited to women. As noted earlier, women disproportionately benefited from educational expansion (Buchmann and DiPrete 2006; Goldin 2006; Mare 1995, 1996), and there is no evidence to suggest that female babies disproportionately benefited from improvements in *in utero* and post-natal conditions. Transition models suggest that cohort declines in the association between LBW and total educational attainment occurred where educational
expansion predicts that they would occur. Specifically, they were the result of a decline in LBW children’s reduced prospects of completing high school, with limited gains at the transition from high school graduation to any post-secondary schooling. Again, it is not clear why the benefits of improved health would apply specifically to certain educational transitions but not to others.

That is not to say improvements in pre- and post-natal health did not contribute to observed trends. As noted earlier, results from race-stratified analyses demonstrate weaker cohort declines in the educational consequences of LBW than an education-only hypothesis would suggest. Although black Americans have benefited from educational expansion more than white Americans, both groups experience similar cohort declines in the association between LBW and educational attainment. A possible explanation is that persistent (if not growing) black-white birth weight disparities prevented larger education-driven declines across cohorts.

Prior research also suggests that health improvements might contribute to the observed patterns. For example, Maruyama and Heinesen (2013) find diminishing returns to normal birth weight for Danish children born between 1981 and 2010. Their sample is too young to examine educational attainment, but the researchers focus on declines in LBW’s importance for infant mortality, permanent disability, and hospitalization (including the number of days a child spends in the hospital before his second birthday). Differences between medical systems in the United States and in Denmark notwithstanding, this finding offers some face validity to idea that the health and cognitive pathways between LBW, academic performance, and educational attainment also weakened.

Implications for future life chances

What do these results mean for children’s life chances? The current analyses find that this improvement in the early-life health of disadvantaged children cascades through the life course.
Not only has the influence of maternal education on children’s birth weight weakened across cohorts, the educational consequences of LBW have also weakened. Thus the educational prospects of historically disadvantaged groups may now be brighter than they were throughout the twentieth century.

Importantly, research that reports child health—including LBW—is a strong determinant of social mobility based on analyses of 1940s or 1950s birth cohorts (e.g., Palloni et al. 2009) might overestimate child health’s contribution to the reproduction of inequality. Estimates suggest that LBW’s long arm might have disappeared starting for children born in the 1960s, just when a number social welfare programs (e.g., Medicaid) and child health interventions (e.g., Child Nutrition Act of 1966) premiered, and the number of new higher education institutions ballooned (Snyder and Dillow 2013). Social welfare programs targeting the least advantaged members of society might have important cascading impacts on the future distribution of inequality that estimates from older cohorts might not capture.

Nonetheless, a number of limitations warrant consideration. First, I only examine one aspect of early-life health, namely LBW. Capturing child health with a single-item measure means my analyses are a snapshot of child health at a single point during childhood. Moreover, birth weight, especially when dichotomized, is a crude measure that summarizes a diverse set of exposures and risk factors (Almond, Chay, and Lee 2005; Kline, Stein, and Susser 1989; Boardman, Finch, and Hummer 2001).

Nonetheless, LBW is an especially visible aspect of child health that is consistently measured across time, and a robust set of literature has documented its links with later childhood health and educational attainment (Conley, Bennett, and Strully 2003a). Focusing on LBW is an
appropriate first step, and future work can extend these findings by including additional conditions.

Second, I cannot disentangle whether observed declines in the effect of LBW on educational attainment are attributable to declines in the causal consequences of LBW or to declines in unobserved characteristics that cause both LBW and lower educational attainment. Although evidence suggests that LBW lowers educational attainment, the relationship between LBW and educational attainment might also be indirect or even spurious. That is, the appearance of a direct association between LBW and educational attainment may be an artifact of differences in biological, genetic, and socioeconomic circumstances between LBW and healthy birth-weight children (Conley, Bennett, and Strully 2003b). On this account, those other differences are what actually affects educational attainment. Because they also cause LBW, there is an appearance of a direct relationship. From this perspective, LBW itself does not have educational consequences, but is a visible marker for biological, social, and genetic factors that limit an individual’s schooling chances.

Policy implications differ depending on which pathway links LBW and educational attainment weakened across 1940-1985 birth cohorts. Cohort declines in the causal component of the relationship between LBW and education suggest that continued investment into medical technologies and educational expansion ought to be the focus of social welfare programs to reduce educational inequalities. In contrast, the cohort declines in the indirect (non-causal) component suggests that such efforts might have only limited success. To investigate the extent to which LBW causally affects educational attainment, some prior research has relied on variation within families or has relied on instrumental-variables approaches. Unfortunately, these studies do not help to disentangle the two possible pathways between LBW and educational
attainment. No dataset to my knowledge has sufficient data to use such approaches to examine cohort trends in LBW’s educational consequences.

Third, I was only able to examine the attainment of children born in or before 1985, as individuals born more recently might still continue to attain more schooling. Since the 1980s, the incidence of LBW births has actually increased, in part due to an increase in the number of Caesarean sections and multiple-child births, as well as to improved survival among premature births (Child Trends Databank 2015; Mathews and MacDorman 2007). The extent to which the increase in low weight births due to these emergent trends will reshape the relationship between LBW and educational attainment is unknown. My results suggest that barriers to attaining any post-secondary education re-emerged in the 1980s. As children born in more recent cohorts age, we can see if these new health trends continue along that trajectory.

These limitations notwithstanding, my findings extend an important body of literature that examines the contributions of LBW to the reproduction of advantage across generations. Improvements in medical care and the expansion of educational opportunities have likely weakened and even eliminated LBW’s role in this process. Therefore, these results suggest that LBW is a malleable determinant of life chances that can be influenced by macrosocial patterns and investments in social welfare and/or medical investments.
# Tables and Figures

Table 4.1. Percentage or mean (and standard deviation) for key sample characteristics, by birth weight (n=5,932)

<table>
<thead>
<tr>
<th></th>
<th>Birth weight(^a)</th>
<th>Significance of difference(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (7.47%)</td>
<td>Normal (92.53%)</td>
</tr>
<tr>
<td>Education (yrs)</td>
<td>12.06 (2.32)</td>
<td>12.41 (2.28)</td>
</tr>
<tr>
<td>Mother’s education (yrs)</td>
<td>11.97 (2.66)</td>
<td>12.43 (2.66)</td>
</tr>
<tr>
<td>Missing (%)</td>
<td>17.33</td>
<td>15.12</td>
</tr>
<tr>
<td>Father’s education (yrs)</td>
<td>10.31 (4.96)</td>
<td>10.86 (4.92)</td>
</tr>
<tr>
<td>Missing (%)</td>
<td>13.33</td>
<td>11.26</td>
</tr>
<tr>
<td>Father’s Occ. Prestige</td>
<td>29.73 (14.85)</td>
<td>34.06 (16.78)</td>
</tr>
<tr>
<td>Missing (%)</td>
<td>33.56</td>
<td>27.86</td>
</tr>
<tr>
<td>Maternal age at birth</td>
<td>25.10 (5.63)</td>
<td>25.73 (5.51)</td>
</tr>
<tr>
<td>First birth to mother (%)</td>
<td>35.78</td>
<td>35.21</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>2.92 (2.41)</td>
<td>2.03 (2.58)</td>
</tr>
<tr>
<td>Nonwhite (%)</td>
<td>57.78</td>
<td>44.36</td>
</tr>
<tr>
<td>Parents married at birth (%)</td>
<td>73.33</td>
<td>83.03</td>
</tr>
<tr>
<td>Female (%)</td>
<td>59.78</td>
<td>51.18</td>
</tr>
<tr>
<td>Birth year (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1940-49</td>
<td>4.67</td>
<td>5.37</td>
</tr>
<tr>
<td>1950-59</td>
<td>22.67</td>
<td>20.36</td>
</tr>
<tr>
<td>1960-69</td>
<td>21.33</td>
<td>22.54</td>
</tr>
<tr>
<td>1970-79</td>
<td>27.78</td>
<td>26.47</td>
</tr>
<tr>
<td>1980-85</td>
<td>23.56</td>
<td>25.26</td>
</tr>
</tbody>
</table>

Data: Panel Study of Income Dynamics (PSID)

\(^a\) Low birth weight is defined as weighing under 2,500 grams at birth

\(^b\) Calculated by t-test (for continuous variables) or chi-square test (for categorical variables)
Table 4.2. OLS estimates of cohort trends in the association between low birth weight and total educational attainment (in years), 1940s – 1980s birth cohorts (n = 5,932)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low birth weight (LBW)</strong></td>
<td>-.219(.089)*</td>
<td>-1.423(.402)***</td>
</tr>
<tr>
<td><strong>LBW x</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1940-49</td>
<td>---</td>
<td>Ref.</td>
</tr>
<tr>
<td>1950-59</td>
<td>---</td>
<td>1.011(.442)*</td>
</tr>
<tr>
<td>1960-69</td>
<td>---</td>
<td>1.116(.444)***</td>
</tr>
<tr>
<td>1970-79</td>
<td>---</td>
<td>1.528(.435)***</td>
</tr>
<tr>
<td>1980-85</td>
<td>---</td>
<td>1.289(.445)***</td>
</tr>
<tr>
<td><strong>Mother’s education</strong></td>
<td>.125(.011)***</td>
<td>.126(.011)***</td>
</tr>
<tr>
<td><strong>Missing</strong></td>
<td>1.526(.168)***</td>
<td>.126(.168)***</td>
</tr>
<tr>
<td><strong>Father’s education</strong></td>
<td>.073(.006)***</td>
<td>.073(.006)***</td>
</tr>
<tr>
<td><strong>Missing</strong></td>
<td>.485(.138)***</td>
<td>.480(.138)**</td>
</tr>
<tr>
<td><strong>Father’s Occ. Prestige</strong></td>
<td>.015(.002)***</td>
<td>.015(.002)***</td>
</tr>
<tr>
<td><strong>Missing</strong></td>
<td>.252(.085)***</td>
<td>.242(.085)**</td>
</tr>
<tr>
<td><strong>Mother &lt; 25 at birth</strong></td>
<td>-.224(.053)***</td>
<td>-.224(.053)***</td>
</tr>
<tr>
<td><strong>Mother 35+ at birth</strong></td>
<td>.342(.094)***</td>
<td>.343(.093)***</td>
</tr>
<tr>
<td><strong>Number of siblings</strong></td>
<td>-.176(.017)***</td>
<td>-.175(.017)***</td>
</tr>
<tr>
<td><strong>Parents married at birth</strong></td>
<td>.241(.070)***</td>
<td>.242(.070)**</td>
</tr>
</tbody>
</table>

† p ≤ .1* p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: Panel Study of Income Dynamics (PSID)

Standard errors are in parentheses. All models include main effects for birth cohort, sex, race / ethnicity, and whether a child was a mother’s first birth.
Figure 4.1. Plot of the estimated cohort trends in the association between low birth weight and total educational attainment (in years), 1940s – 1980s birth cohorts

Table 4.3. Linear probability estimates of cohort variation in the association between low birth weight and education at key educational transitions, 1940s – 1980s birth cohorts

<table>
<thead>
<tr>
<th>Transition 1: &lt; HS → HS</th>
<th>Transition 2: HS → Postsecondary</th>
<th>Transition 3: Postsecondary → College Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low birth weight LBW x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1940-49</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>1950-59</td>
<td>.146(.074)*</td>
<td>-.003(.134)</td>
</tr>
<tr>
<td>1960-69</td>
<td>.144(.074)†</td>
<td>.144(.135)</td>
</tr>
<tr>
<td>1970-79</td>
<td>.226(.073)**</td>
<td>.090(.132)</td>
</tr>
<tr>
<td>1980-85</td>
<td>.147(.074)*</td>
<td>.062(.136)</td>
</tr>
</tbody>
</table>

\[N\] 5,932  4,228  2,093

\[^{†}\] \( p \leq .1^{*} p \leq .05, \quad \star \star \quad p \leq .01, \quad \star \star \star \quad p \leq .001\]

Data: Panel Study of Income Dynamics. Standard errors in parentheses. All models include main effects for sex, race / ethnicity, whether a child was a mother’s first birth, mother’s education, father’s education, father’s occupational prestige, mother’s age at birth, number of siblings, and parental marital status at birth.
Figure 4.2. Plot of cohort variation in the association between low birth weight and education at key educational transitions, 1940s – 1980s birth cohorts.
Table 4.4. Variation in cohort trends in the association between low birth weight and total educational attainment by sex and race, 1940s – 1980s birth cohorts

<table>
<thead>
<tr>
<th></th>
<th>Educational attainment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n = 2,843)</td>
</tr>
<tr>
<td>Low birth weight</td>
<td>-.418 (.315)</td>
</tr>
<tr>
<td>LBW x cohort</td>
<td>.112† (.068)</td>
</tr>
</tbody>
</table>

|                          | White (n = 3,289)      | Black (n = 1,911) |
| Low birth weight         | -.642* (.277)          | -.693** (.267)    |
| LBW x cohort             | .141* (.061)           | .138* (.055)      |

† p ≤ .1* p ≤ .05, ** p ≤ .01, *** p ≤ .001

Data: Panel Study of Income Dynamics. Unless stratified by that characteristic, models include main effects for sex, race / ethnicity, whether a child was a mother’s first birth, mother’s education, father’s, father’s social class (and an indicator for missing), parents marital status at the child’s birth, mother’s age at birth (<25 years, ≥ 35 years), and number of siblings.
APPENDIX

Figure 4.A1. “Decision tree” for key educational transitions
Chapter 5
Conclusion and Next Steps

In this dissertation, I examined how child health’s role in the intergenerational reproduction of educational disadvantage has changed across twentieth- and twenty-first-century birth cohorts. Overall, my results offered suggestive evidence that child health has become a weaker channel through which educational attainment is transmitted from parents to children. In this concluding chapter, I review my major findings before offering some potential future research directions. I then assess what my observed trends mean for children’s life chances in an era of rising social inequality.

Summary of Findings

Association between parental (maternal) education and child health

The first two analytic chapters focused on the relationship between parental socioeconomic resources and child health—also called the “maternal education gradient in child health.” In the first analytic chapter (Chapter 2), I used data from the National Health Interview Studies (NHIS) to examine trends in the association between maternal education and subjective health across children born between 1965 and 2013. A large body of literature has examined the maternal education gradient in child health but has assumed that it is fixed across birth cohorts. Yet prevailing patterns of health, educational attainment, and social inequality all suggest that the health-promoting importance of increased maternal education might have changed across birth cohorts. The rising floor of children’s health coupled with decreasing educational selectivity suggests the maternal education gradient has weakened across birth cohorts, whereas rising social inequality suggests that it has strengthened.
Consistent with improvements in children’s overall wellbeing, I found that the total maternal education gradient in children’s health substantially weakened across cohorts: children born in 2013 enjoyed about 40 percent less health protection from each year of maternal education than did children born in 1965. Most of this decline was due to a decrease in the share of the total maternal education gradient in child health likely attributable to more-educated mothers’ possession of greater cognitive and non-cognitive skills and greater knowledge about health phenomena than less-educated mothers. Meanwhile, social inequality trends offset one another. The association between family income and child health weakened across cohorts, whereas the association between family structure and child health strengthened. That is not to say that rising social inequality did not affect the maternal education gradient across cohorts. Health-friendly family structures became more protective of children’s health across 1965 to 2013 cohorts, and tightening connections between education and income offset cohort declines in the income gradient in child health.

But did these cohort trends extend to other measures of child health? Parent-rated subjective health is predictive of future health events and mortality but, as a summary measure, might obscure important underlying heterogeneity. Therefore, I turned to considerations of cohort trends in the maternal education gradient in reported health conditions in my next empirical chapter, focusing on American children born between 1979 and 2013.

Before turning to cohort trends, however, I first filled a gap in the literature and examined the cross-sectional relationship between mother’s education and child health. Reported health conditions capture both actual health phenomena and parents’ ability to recognize health conditions. Thus, contrary to the maternal education gradient in subjective health, I find that higher levels of maternal education imply higher probabilities of having a reported condition.
14 years of education, however, this gradient flattens then reverses. Although I cannot directly test why this relationship exists or why it reverses, one possibility is that increased educational attainment is associated with increased conscientiousness, better quality care, and other qualitative differences in interactions with health systems. Variation in the gradient across eleven different reported health conditions offered indirect support for this hypothesis.

With the direction of the gradient established, I then turned to cohort trends in the maternal education gradient in diagnosed conditions. Examining trends in diagnosed conditions provides crucial insight into whether changing health and education policies and/or other social forces have reshaped socioeconomic gradient in children’s health. Here, I found that the gradient “flattened” across 1979-2013 birth cohorts. Maternal education has become less associated with having a parent-reported health condition. However, these decreases mainly occurred for the maternal education gradients in asthma and respiratory allergies rather than for the other nine conditions. Decreases were also more pronounced for children of more-educated mothers rather than for children of mothers without a college education. As I argued in the chapter, this pattern of cohort trends is consistent with twentieth- and twenty-first-century increases in access to health knowledge.

**Association between child health and educational attainment**

Weakening ties between mother’s education and child health imply that, all else equal, child health has become less consequential for the intergenerational reproduction of educational disadvantage across mid-twentieth and early-twenty-first century birth cohorts. However, diminishing or strengthening educational consequences of child health can amplify or offset the declining importance of child health for intergenerational mobility. To address this possibility, I examined whether the association between poor early-life health and educational attainment
changed across birth cohorts (Chapter 4). I used data from the Panel Study of Income Dynamics (PSID) covering individuals born between 1940 and 1985. I focused on low birth weight (weighing < 2,500 grams or 5.5 pounds at birth) as a measure of child health because it is consistently measured across time and is a well-established determinant of educational attainment (Black, Devereux, and Salvanes 2005; Conley and Bennett 2000; Conley, Strully, and Bennett 2003a). The expansion of educational opportunities coupled with medical advances largely suggests that low birth weight might have become a weaker barrier for attaining more schooling.

In this chapter, I started by illustrating cohort trends in the association between birth weight and total educational attainment. These initial results revealed a substantial decline in the education disadvantage stemming from early-life health. Beginning with 1960s birth cohorts, low birth weight was no longer associated with lower educational attainment. However, educational expansion did not occur uniformly across levels of schooling. In light of this unevenness, I then asked where the educational consequences of low birth weight individuals have occurred. Consistent with my hypotheses based on maximally maintained inequality (MMI), I found that low birth weight’s influence on high school graduation declined before its influence on postsecondary education declined. Suggestive evidence from sex- and race-stratified analyses were consistent with the claim that both educational expansion and medical advances could be potential explanations for the observed decline in the educational penalties associated with low birth weight.

**Unanswered questions and future directions**

The results offer broad support for the idea that child health has become less important in reproduction of advantage across birth cohorts. However, they are merely suggestive of this
possibility because differences in my measures of child health across chapters do not allow me to
directly compare trends, even within the 1979-1986 birth cohorts present in all three analytic
chapters. Moreover, methodological and sample size limitations mean that I cannot test if the
causal effect of mother’s education on child health and if the causal effect of child health’s effect
on educational attainment have each decreased across cohorts. To truly answer if child health’s
importance as a channel of educational mobility has changed in magnitude, I would need to
verify that the causal components of observed relationships followed the same declines as the
overall relationship itself. Future research should make efforts towards establishing this
causality.

Future research can also answer a number of other questions:

How do trends in maternal health affect the trends that I present? My results on
the maternal education gradient in children’s health contrast research on the education
gradient in individuals’ own health. Adults’ own education has become increasingly
predictive of better subjective health across cohorts (Goesling 2005; Lynch 2003, 2006).
As mother’s health is transmitted across generations (Ahlberg 1998; Conley, Strully, and
Bennett 2003a; Currie and Moretti 2007), this increased adult gradient could offset even
larger gains among children. Future research can interrogate cohort trends in the
intergenerational transmission of health status.

How might immigration patterns influence observed trends? The later part of the
twentieth century witnessed a dramatic increase in immigration to the United States. This
influx of immigrants might account for some of the decreases in maternal education
gradient in child health. The well-documented “healthy immigrant” effect demonstrates
that education gradients are weaker in foreign-born populations than in native
populations, but vary considerably by country of origin (Kimbro et al. 2008). Health care access also varies by immigrants’ country of origin, citizenship status, and time in the United States (Hernandez and Kimbro 2013). Future research can interrogate how immigration patterns might contribute to some of the observed cohort trends in the maternal education gradient in child health.

**Has the association between paternal educational and child health changed across birth cohorts?** Has the association between parental education and child health changed across birth cohorts? Chapters 2 and 3 focus on the association between maternal education and child health. I choose to examine maternal education because mothers tend to spend more time interacting with their children than fathers (Ramey and Ramey 2010; Hurst 2010), and mothers are more likely than fathers to take their children to access preventative health care (Case and Paxson 2001). Moreover, focusing on mothers allows me to examine the relative importance of increasing father absence in explaining cohort trends in children’s health.

However, fathers also contribute to children’s health and their life chances. Their educational attainment contributes to the total stock of economic and non-economic resources within the household. Examining trends in the paternal education gradient in child health and in the parental education gradient (accounting for both parents’ education) across the twentieth century might reveal different patterns than the ones presented in this dissertation. Beller (2009) shows that examining only one parent’s socioeconomic resources as a proxy for the family’s resources can obscure intergenerational processes. She demonstrates that joint-parent measures of class reveal cohort declines in social fluidity but single-parent measures suggest stability in social
fluidity across cohorts. Therefore, examining trends in parental education gradients in child might lead to different estimates of cohort declines in education gradients in child health.

**Do other aspects of child health continue to have long arms across birth cohorts?**

My final empirical chapter examines cohort trends in the association between low birth weight and educational attainment, yet the relationship might differ for other aspects of child health. An individual’s stature as an adult reflects his cumulative health advantages as child. Although height is partly genetically determined, differences in average height tend across groups are due to environmental contexts and exposures (Steckel 1995). For example, infectious disease, undernutrition, and acute inflammation are all associated with reduced adult stature (Crimmins and Finch 2006; Fogel 2004; Li, Manor, and Power 2004). (See Beard and Blaser 2002 and Case and Paxson 2010 for detailed reviews of the determinants of height).

To my knowledge, only one paper has examined cohort trends in height and educational attainment across birth cohorts. Magnusson and colleagues (2006) examined Swedish men born between 1950 and 1975 and find that the association between height and education has attenuated across birth cohorts, albeit slightly, due to declines in undernutrition and the incidence of infectious diseases. However, despite these marked improvements that raised the floor of children’s health across the mid-twentieth century, height remained strongly associated with educational attainment even for men born in the 1970s (the youngest in their sample). Because of differences in infectious disease rates across the Swedish and American contexts (Haas and Oi 2015), a similar decline might not have occurred in the United States.
How do distributional changes fit in? How do individual-level changes in the relationship between family background, child health, and adult attainment unfold on the population level? Otis Dudley Duncan (1967) articulated how population renewal is intimately linked to the reproduction of inequality. Marriage, fertility, and mortality co-determine the number of children exposed to the parent-child dynamics described in the majority intergenerational research. These “population metabolism” processes help allocate the distribution of disadvantage in the population across generations (Preston and Campbell 1993; Mare and Maralani 2006; Maralani 2013). Differences in marriage and childbearing patterns between those with poor childhood health have the potential to exacerbate (or diminish) the transmission of advantage and disadvantage.

Is there regional variation in the evolving importance of health in inequality and mobility processes, as well as in the production of health? The individual-level trends I described in this dissertation may not be uniformly experienced across the American population. Chetty and colleagues (2014) reaffirm the importance of understanding the geography of inequality and mobility. Beyond potentially highlighting how some areas did not experience the same reduced education gradient as other areas, moving my dissertation question to smaller geographic units would allow me to examine contextual variables, such as income inequality, welfare assistance, Medicaid generosity, pre-K availability, and racial composition, in greater detail. Consideration of these additional factors may help to uncover the puzzle of unexplained portions of the decreasing education gradient in child health.

Is the selectiveness of the institution that one attends patterned by child health status? A third broad area of future inquiry concerns differences in the type of education
attained by individuals sick in childhood compared to their healthier counterparts. Horizontal—not only vertical—stratification is becoming an important in determining who receives society’s fruits. Samuel Lucas’s theory of effectively maintained inequality (EMI) suggests qualitative differences in schools and schooling (e.g., the prestige of the institution, the field of study) will not allow the mobility benefits of expansion to be experienced. Sicker children may be increasingly able to attend college, but their experience (and degree) will not be viewed equally with that of someone who attends a more selective school.

By considering these additional questions and explicating the importance of both micro- and macrosocial factors and intra- and intergenerational processes, these next steps can shed light on the production of social and health inequalities. The durability of these relationships helps to uncover how and why inequality influences health and health influences inequality. The malleability of these relationships and their interrelatedness has an inherent orientation towards policy-relevant and policy-informative work. As James Heckman (2006) notes, early interventions are the most cost-effective. Clarifying the long-term intragenerational and intergenerational implications of child health amid marked social and economic change can underscore the importance of policy decisions aimed at the individual and/or family level.

**Implications**

**Did rising tides raise boats?**

Through rich description, my dissertation builds on a growing empirical literature that depicts the importance of child health in social stratification. I extent this body of research by offering a wider perspective that moves beyond a snapshot view and examines change over cohorts. In the process, I have illustrated that shifting macrosocial patterns have the potential to
reshape the intergenerational transmission of inequality. A number of improvements in children’s early-life contexts (e.g., through vaccines and nutritional interventions) likely have raised the floor level of child health across 1965-2013 birth cohorts. The expansion of higher education during the mid-twentieth century has allowed individuals with poor early-life health to attain more schooling. These findings are consistent with the notion that child health has become a less important influence on children’s life chances beginning for those born in the later part of the twentieth century.

My results also help to clarify the long-term intragenerational and intergenerational implications of child health amid marked social and economic change. Across analytic chapters, I found evidence that the changing production of education and the changing production of health have each contributed to the declining importance of child health across cohorts; policy helped to propel these changes. As described in my final empirical chapter, nutrition interventions and other policies focused on children have likely improved early-life health and lessened its consequences across birth cohorts. Expanded Medicaid access and the introduction of child-specific health insurance policies (e.g., SCHIP) have also helped to improve children’s health starting in the latter half of the twentieth century. The contribution of such policies to observed trends underscores the importance of policy decisions aimed at the family and/or child level for decreasing inequality across the life course.

My dissertation also contributes to a growing body of research that examines the links between rising social inequality and social mobility. As noted in the dissertation’s introduction, there is no necessary relationship between inequality and mobility, but a number of theoretical and empirical results lend credence to the claim that increasing inequality implies decreasing mobility (Cameron and Heckman 2001; Hout 2004; Mitnik, Cumberworth, and Grusky 2013;
Morgan 2006; Smeeding et al. 2011). Influential papers calling attention to children’s increasingly unequal contexts work from this assumption and provide strong evidence supporting it. McLanahan (2004) and Fuchs (1992) each describe how changing distribution of children across family configurations and poverty status, respectively, suggests that rising social and economic inequality has likely hampered less-advantaged children’s life chances starting in the late twentieth century.

My results paint a more optimistic portrait than McLanahan’s and Fuchs’ articles. Each of my empirical chapters presented evidence that the worst-off members of society—either those raised by mothers with low levels of education (Chapters 2 and 3) or those born low birth weight (Chapter 4)—have faced increasingly better life chances. Distributional changes, on the other hand, imply that children on the bottom of the socioeconomic distribution have started to face increasingly impaired life chances. The evidence that I present in this dissertation does not refute these earlier claims, as both McLanahan and Fuchs focus on the changing allocation of resources across children, and I focus on the changing meaning of those resources for children’s health. However, my results add additional nuance (and their results add nuance to my findings).

For example, since the 1960s, children have faced countervailing forces that dynamically reshape children’s life chances. Although family income has become increasingly unequal across birth cohorts, income has become less important for the production of child health. McLanahan (2004) finds that socioeconomically disadvantaged children are more likely to end up in single-parent homes, have young parents, and have more siblings than their more advantaged peers, and I find that these family configurations have become more predictive of poor health. However, children with poor child health no longer tend to have lower total educational attainments.
My dissertation, therefore, falls into a growing body of research that is finding mixed implications of rising inequality for children’s life chances. Reardon (2011) powerfully demonstrates that, across the twentieth century, higher parental income has become increasingly predictive of higher test scores. Yet this trend does not extend completed educational attainment: income has not become increasingly predictive of children’s completed educational attainment for children between 1954 and 1985 (Duncan, Kalil, and Ziol-Guest 2013). However, income gaps in test scores, total educational attainment, college attendance, and college graduation have all widened across those same birth years. Policy interventions that seek to improve children’s life chances amid rising social inequality must consider both changes in the allocation of exposures and changes in the consequences of those exposures.

Overall, my dissertation has added to our understanding of the implications of rising social inequality for children’s life chances. While inequalities linger and contribute to the intergenerational persistence of disadvantage, basic improvements in health and in educational opportunities have left child health a weaker channel through which educational attainment is transmitted from parents to children.
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