ABSTRACT

Title of Document: IMPACT OF CHILDHOOD AND ADOLESCENT CHRONIC HEALTH CONDITIONS ON EDUCATIONAL ATTAINMENT

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BACKGROUND: Youth with chronic health conditions face challenges that may prevent them from achieving their educational goals.

PURPOSE: This dissertation examined whether children and adolescents with chronic health conditions were more likely to have poor educational attainment compared to youth without chronic health conditions. It examined the impact of type and onset of chronic health conditions as well as youth limited by chronic health conditions on educational attainment. The potential influences of mediating and moderating factors were also investigated.

METHODS: Using data from the National Longitudinal Study of Youth - Cohort 1997, multivariate logistic regression models were fit to examine the associations between type, onset of chronic health conditions, as well as youth limited by chronic health conditions and their impact on educational attainment. The cohort's sample size was 8,984 and participants were followed up through 2009. Chronic health conditions were defined by the 1997 parent questionnaire and the 2002 youth questionnaire. Educational attainment was defined by completion of high school by 21 years of age. Academic, psychosocial, neighborhood and school factors were examined and potential mediators and effect modifiers were identified.

RESULTS: The odds of poor educational attainment for youth who reported ever having a chronic health condition were significantly higher compared to youth who never reported a chronic health conditions, OR: 1.47 (95% CI: 1.22 - 1.76). Specifically youth with cancer, diabetes or epilepsy had the highest odds of poor educational attainment, OR: 1.96 (95% CI: 1.13 – 3.37). There were similar associations for youth limited by a chronic health condition, OR: 1.76 (95% CI: 1.33 - 2.34) and for youth with early onset of a condition, OR: 1.61 (95% CI: 1.29 – 1.99). Academic and psychosocial variables attenuated these associations and mediators were present. Interactions with school-level factors and chronic health conditions were also found.

CONCLUSIONS: Youth with chronic health conditions, specifically those with cancer, diabetes or epilepsy, youth limited by or have early onset of a chronic health condition are at particular risk of poor educational attainment. There are strategies that may mitigate these associations such as depressive symptoms screenings and support services in school.

IMPACT OF CHILDHOOD AND ADOLESCENT CHRONIC HEALTH CONDITIONS ON EDUCATIONAL ATTAINMENT

By

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Chapter 1: Introduction

1.1 Background and Rationale

The diagnosis of childhood chronic health conditions has quadrupled over the past four decades.[1] In 2004, 7% of US children were diagnosed with a chronic health condition.[1] An estimated 133 million Americans are living with at least one chronic health condition and about 32 million children currently have at least one of twenty chronic health conditions.[2]

Although each chronic condition is unique, there are similarities with respect to how they affect youth.[3] Children with chronic health conditions are always living with their condition and may require many hospitalizations, home health care and extensive medical care.[3] Not only do these children face everyday life challenges, they may also have a host of medical burdens to negotiate on a daily basis.

For a number of reasons, including school absences, possible cognitive delays and poor psychosocial adjustment, youth with chronic health conditions may be less likely to reach higher educational levels. Educational attainment has major consequences for a person's health. Poor educational attainment is associated with substance abuse, poor health behaviors, income and employment.[4-7]

Medical technology is improving and more children with chronic health conditions reach adulthood each year. 95% of US children with a chronic health condition are now living past 20 years old.[8-11] The harmful effects of poor educational attainment for these youth make examining this association critical. Understanding the factors contributing to or deterring from the association are critical to developing

preventative strategies to keep these children on a successful educational trajectory. The rest of this chapter provides additional background information.

Chronic Condition Definitions

Chronic disease is a term for diseases that are potentially life threatening, have a long duration, frequent re-occurrence and generally slow progression. It is a broad definition for many types of conditions. According to a systematic review and depending on definition, as many as 44% of children have a chronic health condition.[12] There has been no international classification for childhood and adolescent chronic health conditions. In a systematic review of studies performed on childhood chronic health conditions, van der Lee concluded that there were four separate definitions used to classify childhood chronic health conditions.[12] The first definition required a diagnosis based on the International Statistical Classification of Diseases, 10th Revision. According to this definition, the condition must either: (1) have had a 3-month duration, or probably will have at least a 3-month duration and (2) the condition must not have a cure.[12] The second definition was a subgroup of the first level and included individuals (age 18 or younger) with limitations in ordinary activities due to the chronic condition.[12] The third definition was a subset of the first two definitions and defined a chronic health condition by additional health care usage including medical care or services. The final definition involved "children with special health care needs." This group included youth at an increased risk for chronic, physical, developmental, behavioral or emotional conditions as well as youth who require additional health care services. In a later study, Mokkink et al developed a consensus definition designed to be used in large, epidemiological studies in the Netherlands.[13] A definition was developed based on medical diagnoses and not on

the consequences of the disease such as functional limitations or special health care needs. The criteria developed were:

1) The disease occurs in children aged 0 to 18 years
2) The diagnosis is based on medical scientific knowledge and can be established using reproducible and valid methods or instruments according to profession standards
3) The disease is not (yet) curable
4) The disease has been present for longer than three months, will probably last longer than three months or has occurred three times or more during the past year and will probably recur again.

Educational Attainment

Educational attainment is defined by the U.S. Bureau of Labor Statistics as the "highest diploma or degree, or level of work towards a diploma or degree, an individual has completed."[14] High school graduation rates are a measure of educational attainment that is used to assess a society's scholastic aptitude as well as the capability of the future workforce.[15] This measure is assessed by different methods and each approach influences the reported high school graduation prevalence.

Overall high school graduation rate captures the number of graduates over a one-year period, accounting for the number of high school students who graduated versus the number who did not as a percentage. Some measures incorporate the number of students who have received their Graduate Equivalency Degree (GED). These are students who have dropped out of high school and subsequently take the high school educational equivalency test. These persons may be classified as high school "completers" instead

of "graduates".[16] However, including these students could theoretically cause inflation of graduation rates because they are students from previous time periods who were unsuccessful in the education system and are now counted with youth who had successfully completed the education system.[16]

Graduation rates also differ based on when students are assessed. For example, some studies include students who have dropped out of high school while other assessments only include 12th graders who do not graduate. Some studies track the number of 9th graders who graduate four or five years later. Another difficulty with the high school graduation measure is some people have completed 12 years of school without graduating. Determining whether a high school graduation measure includes students from both private and public schools or only public schools also can complicate graduation measures.[17]

The United States high school graduation rate has been a difficult statistic to estimate based on the above considerations as well as the different data sources implemented and the methodology and analysis used. The high school completion definition used by the National Center for Education Statistics (NCES) is the total number of graduates from public and private schools and GEDs divided by the general population of 18-24 year olds not currently enrolled in high school.[15] This number is 89.9 percent based on the 2010 Current Population Survey, the primary data source for U.S. labor force statistics sponsored jointly by the U.S. Census Bureau and the Bureau of Labor Statistics.[16] *The Condition of Education 2011* implements a number based on the total number of graduates from public and private schools and GEDs divided by the generation population of 25-29 year olds.[15] In 2010, this number was 88.8% based on the

Current Population Survey.[16] The Common Core of Data is a dataset from the National Center for Educational Statistics that estimated the average freshman high school graduation rate for public high school students in 2007-2008 as 74.9%.[15] The average high school graduation rate was estimated by dividing the number of graduates by the estimated count of freshmen 4 years earlier.

Chronic Health Conditions and Educational Attainment

Past studies examining the association between chronic health conditions and educational attainment have been inconsistent in the US. Childhood chronic health conditions have been associated with unemployment and lower income but there are conflicting results with high school graduation.[8,18,19] This is partially because of issues with classification and categorization of chronic health conditions. For example, some studies include asthma with other severe chronic health conditions.[17] This is a limitation of past research as some studies categorize chronic health conditions together without regard to type, youth limited by the chronic health condition or onset of a chronic health condition.[12,13] It is a hindrance because studies form conclusions about all chronic conditions when there are a variety of chronic conditions in terms of type and onset as well as differences in severity of the chronic health condition. These variations can obscure relationships with a student's educational attainment.

Although there have been conflicting results with respect to chronic health conditions and educational attainment in the past, more recent studies have shown an association in the US.[8,19-21] A study using the National Longitudinal Study of Adolescent Health dataset by Maslow et al assessed the association between chronic health conditions and educational attainment.[8] This study categorized youth with asthma

separately from the rest of youth with other chronic health conditions. Compared with healthy young adults, youth with non-asthmatic chronic health conditions (diabetes, cancer and epilepsy) were significantly less likely to graduate high school and gain employment and were more likely to receive public assistance.[8] Although youth with asthma were found to have better educational attainment outcomes compared to youth with diabetes, cancer and epilepsy, there is little research on specific types of chronic disease and how each affects educational attainment.[8]

1.2 Research Questions and Hypotheses

The overall research question was "do childhood and young adolescent chronic health conditions affect educational attainment?" It was hypothesized that there would be an association between youth with chronic health conditions and poorer education attainment in general. Other research questions included, "are there high risk groups in this association?" and "are there specific contextual factors from the family, school and neighborhood that compound or deter this association?" We hypothesized that youth with early onset of a chronic health condition and youth limited by a chronic health condition would have the highest odds of poor educational attainment and would comprise high-risk groups. It was also hypothesized that the association of chronic health conditions and education attainment is mediated by academic and psychosocial variables and factors from the youth's neighborhood and school serve as effect modifiers.

1.3 Theoretical Framework and Objectives

Theoretical Model: Social Ecological Model

This study investigated the association of chronic health conditions and educational attainment using a social ecological theoretical framework. The social

ecological theory suggests that an individual is influenced by many contextual factors within his or her environment.[22] The social ecological model describes the association between the individual and his or her environment and incorporates the different influences of one's environment that may affect the outcome.[23,24] This model reveals circles of influence where an individual is nested within his or her family. This individual is also nested within a community (See Figure 1). The community includes both the school and neighborhood. In this model, the family is more proximal compared to the community influences. The school is more proximal compared to the neighborhood.

Originally, ecological studies were applied to plants and animals and their habitats, but the model was adapted to characterize humans and their environment. A widely used version of the social ecological model is from Bronfenbrenner's Ecological Systems theory.[25] This model is used in human development and behavior where an individual is within an organization, the organization is within a community and the community is within a culture. Epidemiologists have applied this theory to health and health prevention.[22-24]

The goal of our study was to identify factors to prevent poorer educational attainment for students with chronic health conditions. The social ecological model can be a prevention framework that allows identification of contextual factors from the individual's environment. It helps to describe the complicated interaction of these factors with the individual. This theoretical model allowed us to address contextual factors that put youth with chronic health conditions at risk of poor educational attainment. This model is used in each of the manuscripts. This social ecological theory, combined with

the literature review, was the basis for the introduction of variables from many different levels in our model. Individual level sociodemographic variables, such as gender and race/ethnicity were included in our model. Individual level family background variables included parent education and 2-parent household. Community level variables included type of school, teacher's experience, neighborhood income, and neighborhood education. These variables were important factors to describe the participant's contextual background.

Academic Mediation Theory

Along with our social ecologic model and the ecologic theory, this study also implemented student performance and child development theories to understand the influences of academic and psychosocial factors including potential mediation on this association. Cognitive and social theories of learning and development were incorporated within the framework of the social ecologic model.

Academic mediation theory explains that academic achievement is the mediating factor between variables and their educational attainment including completing high school.[26] There are many aspects involved in academic achievement, learning and development. Academic and psychosocial factors have been shown to effect educational achievement and attainment.[27] This theory is the basis for our use of academic and psychosocial variables as potential mediators.

Cognitive Information Processing Theory

Within the academic mediation theory, there are also multiple learning and development theories incorporated in our framework. The cognitive information processing theory explains that as a child matures, his or her brain progressively develops

an increased capacity that leads to advances in the ability to process and respond to information.[28] This theory focuses on the individual's cognitive processes of thinking and memory.[28] When the child is challenged in school, the brain develops and processing increases. This theory, combined with the literature review, was the basis for my introduction of academic factors as potential mediators between chronic health conditions and educational attainment.[28] The variables focused on the participant's cognitive development from attending classes regularly and their ability on tests and overall achievement. These variables included from this theory included participant's cognitive score, age, grade point average and the number of school absences.

Social Learning Theory

Albert Bandura developed social learning theory that involved the following concepts: (1) people can learn through observation (modeling), (2) mental states and self-efficacy are important to learning and (3) learning does not necessarily lead to a behavioral change.[28,29] This applies to our study because a mother or father who graduated high school can influence their child to reason college graduation is customary. This may motivate the child to graduate from high school. This applies to our study in the neighborhood context as well. If a child was in a neighborhood with many people who had not completed high school, the child may reason that high school graduation is not normal and may be less motivated to complete high school.

Rumberger Framework

Rumberger developed a framework to study a student's performance that integrates the educational literature, and predominant theories.[30] This framework is related to our study's mediation and social ecological frameworks. He suggested that

youth who drop out of high school are in the last stage of a cumulative disengagement process from school.[30] This framework suggests that engagement is related to academic performance, school attendance as well as overall preparation and expectations. At each point in this process, contextual factors from the family, school and neighborhood affect the variables in the framework. Although we did not specifically employ this framework, it gives a concrete background and a potential pathway to our study's models.

Variable Summary

Overall, the individual-level examines sociodemographic, academic and psychosocial variables. These individual level sociodemographic variables included the participant's: (1) age, (2) gender and (3) race/ethnicity. The individual level also examines the family members and peers. These variables included: (1) parent education and (3) 2-parent household. The individual level academic variables included (1) cognitive score, (2) grade point average, (3) school absences and (4) repeated a grade. The individual level psychosocial variables included (1) depressive symptoms score, whether the participant was a (2) victim of bullying and those that (3) felt safe at school. The community-level involves settings such as schools and neighborhoods. These variables included: (1) neighborhood income, (2) neighborhood education, (3) neighborhood race/ethnicity, (4) type of school, (5) 5-year teacher turnover, (6) teachers with advanced degrees, (7) percentage truancy, (8) class size and (9) teacher experience (for an exhaustive variable list refer to Appendix).

Specific Aims

I addressed the following specific aims in my dissertation:

A1: To examine the association between type of chronic health conditions during childhood and adolescence and educational attainment later in life compared to youth without chronic health conditions, while adjusting for confounders and exploring the influences of academic variables, psychosocial variables and the youth's school and neighborhood environment. Academic and psychosocial were also evaluated as potential mediators. (Paper 1)

A2: To examine the association for onset of a chronic health condition, youth limited by a chronic health condition as well as youth limited by and have early onset of a chronic health condition during childhood and adolescence and educational attainment compared to youth without chronic health conditions, while adjusting for confounders and exploring the influences of academic variables, psychosocial variables and the youth's school and neighborhood environment. (Paper 2)

A3: To investigate potential effect modification from the youth's school and neighborhood environment that may effect the association between youth with chronic health conditions and poor educational attainment. (Paper 3)

Previous Literature

In the Maslow study, an association with chronic health conditions and educational attainment was found.[8] Mediating variables for this association were not studied but were mentioned as recommendations for future research. These variables included: (1) altered peer relations, (2) school absences, (3) cognitive impairment, (4) family stress, (5) family financial stress and (6) psychiatric illness.[8]

In 2008, a study by Haas and Fosse utilized the National Longitudinal Survey of Youth '97 to identify the mechanisms by which self-reported health is associated with

educational attainment.[27] There was a significant association between self-reported health and timely graduation from high school and post-secondary enrollment. On a 5-point Likert scale, a one-unit decrease in self-reported health lowered the odds of timely high school completion by 34 percent and lowered odds of postsecondary enrollment by 30 percent.[27]

The study suggested that academic achievement and psychosocial variables are along the causal pathway from young adolescent health to educational attainment. Adding academic achievement variables (GPA, cognitive score, number of absences and repeated a grade) decreased the gap between poor self-reported health and educational attainment. When academic achievement variables (see next sentence for list) were included in the model, a one-unit decrease in self-reported health lowered the odds of timely high school completion to 17 percent compared to 34 percent.[27] These academic achievement variables included math and verbal test scores, grade point average (GPA), number of absences in an academic term, whether the participant had an emotional problem and if the participant had repeated a grade. In addition, adding psychosocial variables (listed below) only slightly decreased the gap between poor self-reported health and educational attainment. When psychosocial variables (see next sentence for list) were included, a one-unit decrease in self-reported health lowered the odds of timely high school completion to 32 percent as compared to 34 percent. Psychosocial variables included if the participant had been threatened at school, had been a victim of bullying, had a physical altercation and whether the participant felt safe at school. Adding both psychosocial and academic achievement variables to the model contributed to a one-unit decrease in self-reported health, lowering the odds of timely high school completion by

16 percent. From these results, the authors concluded that although psychosocial variables are important, academic variables were more strongly associated with health and educational attainment.

This prior study reinforces an important association between health and educational attainment. However, self-reported health was operationalized as either physical or psychological health. The precise aspect of health that contributes significantly to poorer educational attainment was not examined and therefore is relatively unknown. Examining more specific health measures such as type and onset of chronic health conditions as well as youth limited by chronic health conditions and their impact on poor educational attainment are essential to advancing the health and educational attainment literature. Determining these associations' underlying mechanisms is also critical and addresses gaps in the current literature.

Mediation Literature

Our study not only examined the possible association between chronic health conditions and educational attainment but we explored potential mediators and moderators. The previous literature gives credence to studying academic and psychosocial variables as mediators for the association between chronic health conditions and educational attainment. The Haas and Fosse study concluded that academic variables attenuated the effect of self-reported health and educational attainment.[27] Psychosocial variables slightly attenuated the effect of self-reported health and educational attainment.[27] The Maslow study established an association between chronic health conditions and poorer educational attainment and suggested that mediating variables such as achievement variables, including school absences and cognitive impairment, and

psychosocial variables, including psychological illness and family stress, should be investigated.[8,20]

Academic Mediators

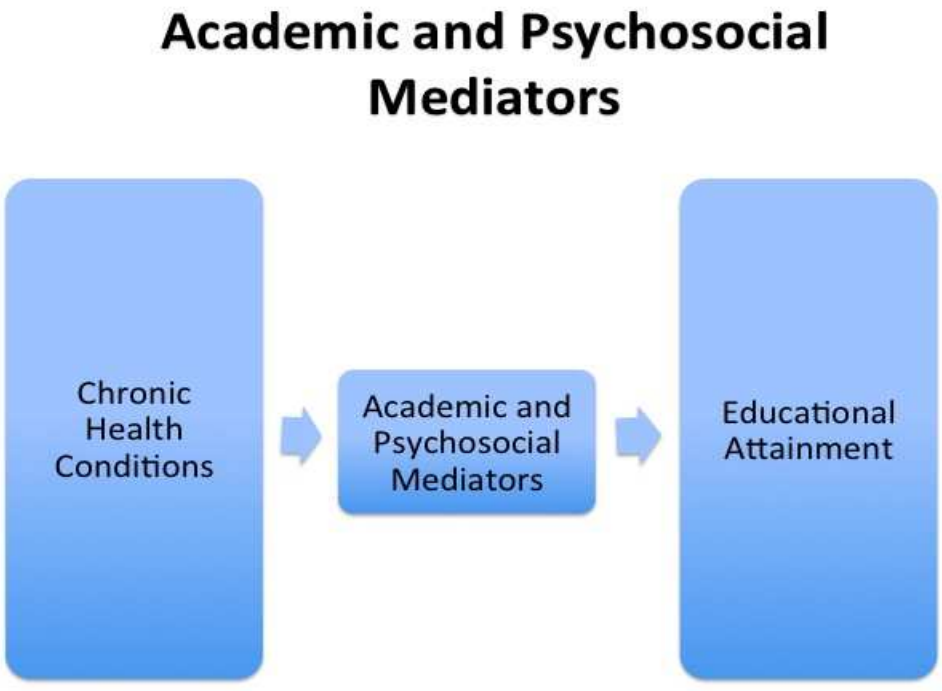
Chronic health conditions can lead to cognitive impairment, which may result in poorer educational attainment. Past research have shown an association with specific chronic health condition in childhood and adolescence with cognition and lower achievement scores.[31,32] This was evident in the cognitive testing of a diabetes type I study.[31] The study assessed the cognitive performance of 51 children with early onset (5 years or younger) diabetes and compared this group to children without diabetes.[31] Children with diabetes had deficits in phonological processing ($F=12.1$, $p<0.01$), spelling accuracy ($F=14.7$, $p<0.01$), and mathematics ($F=5.19$, $p=0.02$) compared with healthy children. They also learned to read at a later age ($\chi 2 =10.85$, $p=0.01$) compared with healthy children.[31] This exploratory study provided a possible biological mechanism for lower educational attainment by showing differences in brain development and academic proficiency. Thus, it is probable that cognitive factors may serve as a mediator in the association of chronic health conditions and educational attainment. However, the study did not measure other factors, such as school absences, that may have explained the differences that were found.

Chronic health conditions may lead to forced absences and poorer achievement independent of cognitive impairment. This was suggested in the Maslow et al study as a possible mediator.[8] These prolonged or frequent absences may lead to poor performance in school and grade repetition. This information guides my investigation of academic and cognitive variables as potential mediators.

Psychosocial Mediators

Chronic health conditions may contribute to a child having poor mental health. It was found that youth Canadian adolescents and children who were chronically ill had more than a two times higher risk of having psychiatric disorder.[33] Youth with chronic illness in childhood and adolescence perform higher on an antisocial scale, an anxious/depressed scale, a peer conflict and social withdrawal scale and behavioral problem index.[33] One study found that depressive symptoms decrease years of schooling completed, increase the probability of dropping out of high school and decrease the probability of college enrollment.[34] Physical limitations due to chronic conditions may lead to limited athletic and social activities.[27] This may result in lower self-esteem and can result in social isolation, poor peer interaction and suboptimal social development.[27] The students with chronic conditions may need medical equipment in the classroom, such as insulin needles or asthma inhalers and may get bullied by peers, and as a result may not feel safe at school. Past research has found bullying, physical and verbal threats can lead to loneliness, school avoidance behaviors, negative school attitudes, and poorer educational achievement.[35,36] Therefore, it is probable that being a victim of bullying as well as poor mental health would both serve as a potential mediator between chronic health conditions and educational attainment. Thus psychosocial factors can mediate the association between chronic health conditions and educational attainment.

Figure 1: Academic and Psychosocial Mediators



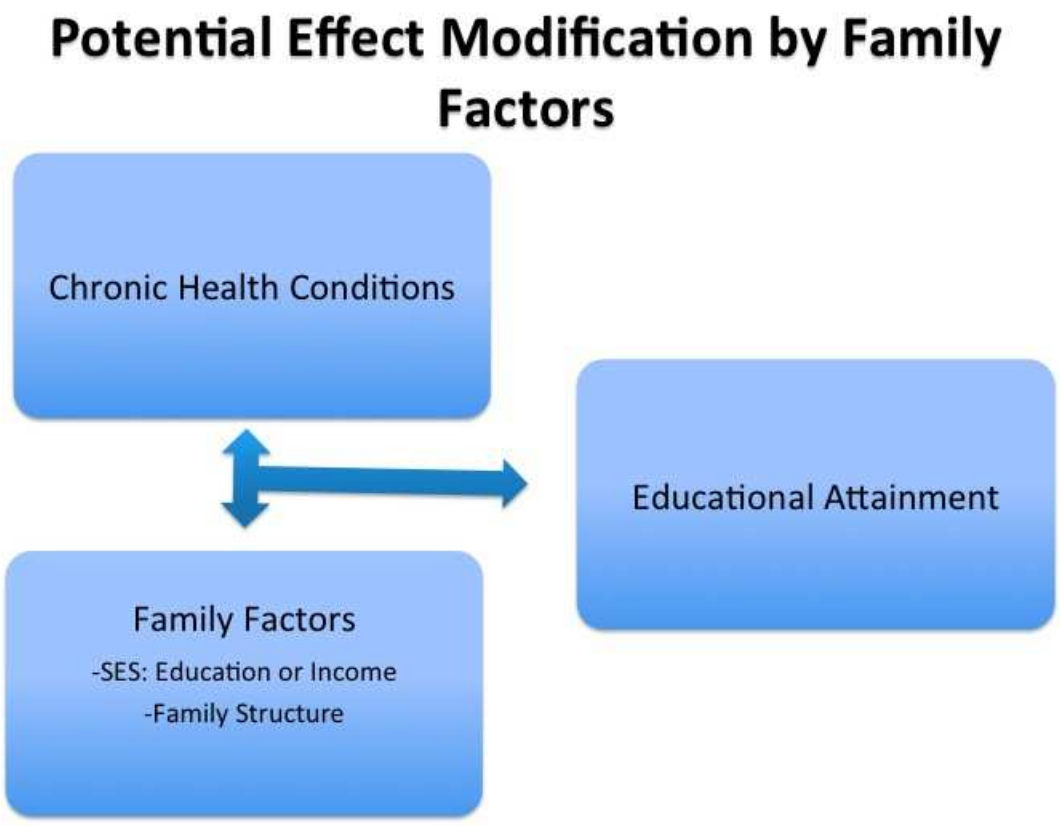
Effect Modification and Contextual Factors Literature

Contextual factors from the family, neighborhood and school factors have all been shown to influence and potentially serve as effect modifiers for a student's performance.[30] The school and neighborhood may deter or promote a successful educational tract for students. A student with a chronic health condition may already be more removed from their education and the influence of the neighborhood or school can contribute or deter him or her from ultimately completing high school. Identifying these factors is important to understanding the influence of the overall environment and may be critical to determining high-risk groups in the association of chronic health conditions and educational attainment.

Family Background: Individual Level

The literature has shown that family background defined as family SES or parent's education level is consistently the most important predictor for a student's educational attainment.[30] Educational attainment is associated with early poverty in a child's life as well as duration of the poverty.[37-39] The National Longitudinal Study on Youth and the Infant Health and Development Project found that poverty in a child's early life as well as the duration of the poverty were associated with educational attainment.[38] If the child is destitute before attending school it affects educational attainment more than if the child becomes disadvantaged after attending school.[37-39] A $10,000 increase in family income during the child's first five years of life results in almost 1 year more of achievement. There is a dose response between poverty and IQ scores; IQ scores are lower among children in poor families by 6 to 13 points after controlling for maternal age, education and ethnicity.[37-39] This IQ effect is seen in many age groups but family poverty has less of an effect in adolescence. Children who are poor are more likely to have a development delay, learning disability, repeat grades, get expelled or suspended, drop out of high school at a higher rate and not be employed or in school at 24 years old.[37-39] Graduation rates are 50% in areas with high poverty.[38] The cumulative effects of poverty are an important influence on educational attainment and our study. Family structure has also been studied. A 2-parent household has been shown to be associated with better educational outcomes compared to single parent or step families.[40]

Figure 2: Potential Effect Modification by Family Factors



School Factors: Community Level

Many school factors are associated with a student's educational achievement and attainment. These factors may modify the effect of chronic health conditions on educational attainment. A student that is burdened with a chronic health condition may already be less involved in school and school characteristics may help or deter the student from educational success. Type of school, school resources, school structure, student composition, student mobility, teacher quality and the school environment are other factors involved in a student's educational achievement attainment. The literature is summarized in the table below. For example, it has been shown that Catholic schools

decrease dropout rates in high school when adjusting for student selection by private schools.[41] It was also found using National Assessment of Educational Progress (NAEP) data that reading scores were 14.7 points higher for private schools compared to public schools with an effect size of 0.41 for 4th graders.[42]

Teachers impact the educational attainment of students. The literature shows that teacher experience, teacher preparation programs and degrees, teacher certification, teacher coursework and teacher test scores impact a student's learning.[43]

School environment plays a role in the educational achievement and educational attainment of students. School-level correlates of poor student achievement include: teacher and student tardiness, lack of academic challenge, vandalism, drug abuse, physical conflicts, verbal abuse of teachers, physical attacks on teachers, teacher absenteeism, student absenteeism, cutting class, apathy, robbery or theft, disrespect of teachers, alcohol abuse and weapons in school.[44] A review of school climate found that higher grades, engagement, attendance, expectations and aspirations, a sense of scholastic competence, fewer school suspension and on time progression through grades were associated with a caring school climate.[45] Each of these factors influence and may modify the relationship with chronic health conditions and educational attainment.

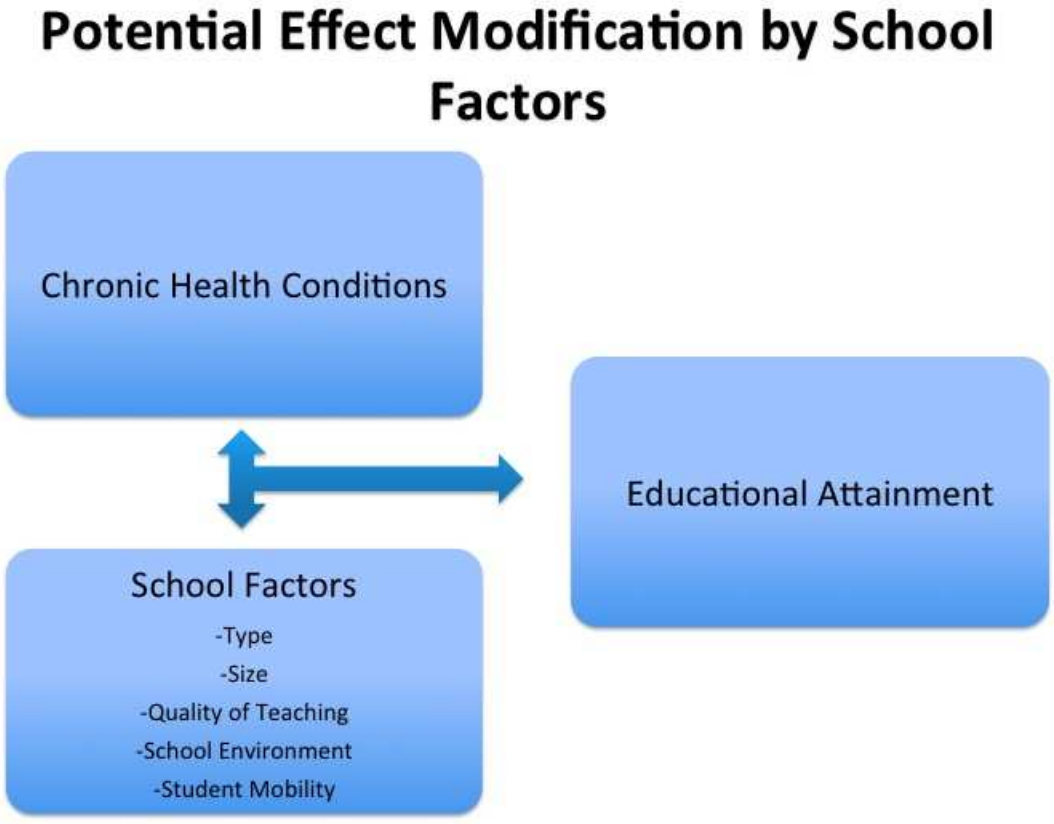
Table 1: Literature for School Level Variables and Educational Attainment

School Level Variables	Dataset Implemented	Year	Outcomes
Type of School	High School and Beyond	1995	Dropout Rates, Lower in Catholic Schools[41]
Type of School	National Assessment of Educational Progress (NAEP)	2003	Mean Reading and Math, Private/Public ,4th and 8th grade[42]
Higher Per Pupil Expenditures	Meta-analysis	1994	Resource Expenditures, Increase Achievement [46]
Higher Per Pupil Expenditures	High School and Beyond	1998	Improvement in Lowest Percentiles of Math Achievement [47]

Higher Per Pupil Expenditures	Washoe County, NV	2006	Improvement in Reading Achievement 3rd, 4th, 5th, 6th graders [48]
Longer School Year/School Day	Meta-analysis	2010	Better Educational Outcomes[49]
Small Class Size	Meta-analysis	2000	Better Academic Performance[50]
Small Class Size	Tennessee Project Star	2005	Kindergarten to 3rd Grade, Higher HS Graduation[51]
School Poverty	Longitudinal Evaluation of School Change and Policy	2001	High Poverty Schools, Lower Achievement[52]
Poverty	National Assessment of Educational Progress (NAEP)	2003	Free or reduced lunch, 4th and 8th grade, Lower academic achievement[39]
Lack of English Proficiency	Current Population Survey, American Community Survey	2010	English Language Learner and Limited English Proficiency students[53]
Lack of English Proficiency	National Assessment of Educational Progress (NAEP)	2010	ELL (English Language Learner) average of 36 scale points lower nationwide[54]
School Race/Ethnicity	National Assessment of Educational Progress (NAEP)	2005	African American, White, School Achievement[55]
School Mobility	School Mobility	2009	Lower Achievement and Higher Dropout[44]
Teacher Quality - Experience	National Assessment of Educational Progress (NAEP)	2000	Elementary school and High school, better achievement [30]
Teacher Quality – Advanced Degree	National Educational Longitudinal Study of 1988 (NELS-1988)	1997	Advanced Math Degrees, 10th grade achievement [30]
Teacher Quality – Advanced Degree	Longitudinal Study of American Youth	1994	No effect for achievement [30]
School Environment	National Longitudinal Study of Adolescent Health	1997	12th graders- connected to family and school, improve health behaviors [56]
School Environment	Meta-analysis	1999	Caring school environment associated with engagement, attendance, expectations and aspirations, a sense of scholastic competence, fewer school suspensions, on time progression and, higher grades 5 studies: Caring school environment associated with high self-esteem and self-concept, 3 studies: Caring school environment associated with less

			anxiety, depression, loneliness, 4 studies: Caring school environment associated with reduction of substance abuse; Sense of belonging also led to higher grades[45]

Figure 3: Model of Potential Effect Modification By School Factors



Neighborhood Factors: Community Level

Neighborhoods may influence health, development, drop out rates and educational attainment. The literature is summarized in the table below. A neighborhood's resources such as number of playgrounds and parks have an association with youth development.[57,58] A student may be influenced to drop out by a youth in the community that has already dropped out of school. Poor educational attainment is also affected by the employment opportunities present for high school dropouts.[59]

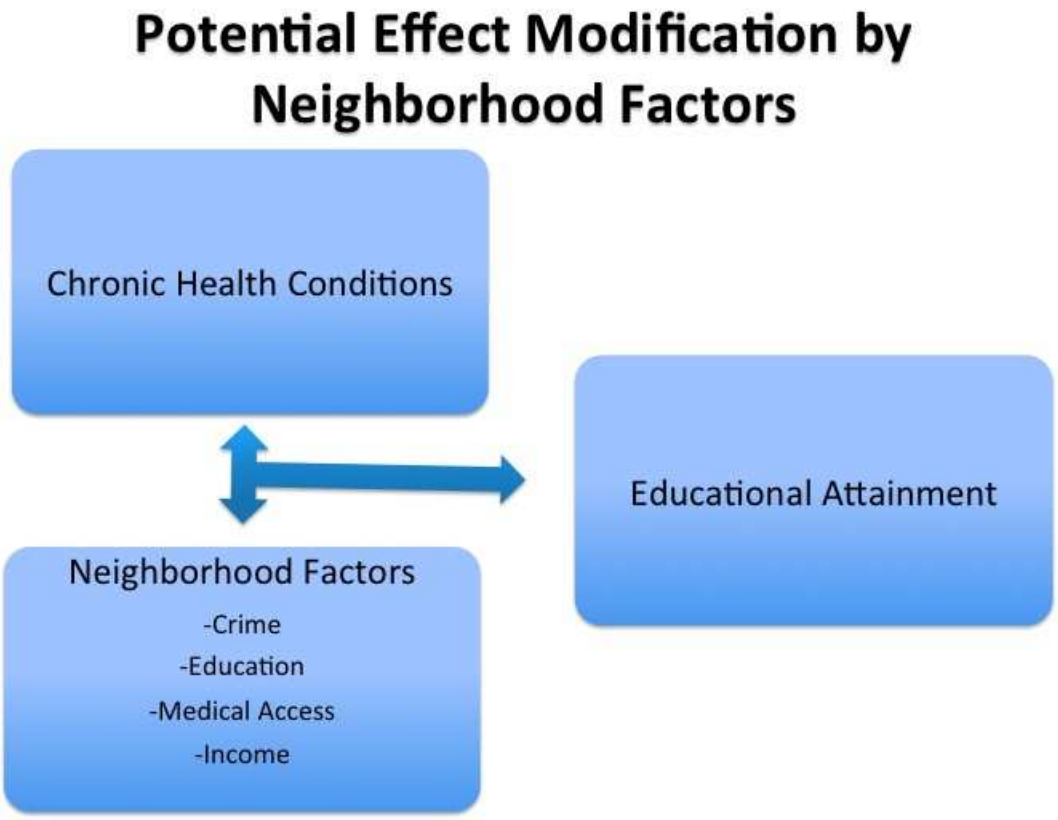
Chronic health conditions are also correlated with neighborhood factors.[60] For example, the incidence of asthma may increase by the air pollution in the neighborhood. The literature on a neighborhood's education-level, income, health access, crime and violence suggests an association with health and youth development (Figure 5).[57-58, 60-63] The neighborhood is known to have effects on depression and other health conditions.[60] Neighborhood crime and violence were associated with psychological distress.[61] In an infectious disease study, authors concluded that education on a population level plays a significant role in health seeking behaviors.[63] These health effects of neighborhoods may affect the association between childhood and young adolescent chronic health conditions and educational attainment by compounding or partially alleviate the chronic health condition of the child. This makes it important to identify the neighborhood's contextual factors and evaluate potential effect modification by these factors.

Table 2: Literature for Neighborhood Level Variables and Health and Youth Development, and Educational Attainment

Neighborhood Variables	Dataset Implemented	Year	Outcomes
Crime and Mental Health	SHIELD (Self-Help in Eliminating Life-Threatening Diseases) Study, Baltimore, Inner City	2008	Block group level crime, violence experienced was related to depression, Psychological Distress[60]
Crime and Mental Health	Meta-Analysis	1998	Violent Crime was associated with psychological Distress, Mental Health Outcomes[61]
Social Capital	School Aged Children Study, Canadian	2010	Social Capital reduces socioeconomic differences in children's psychological symptoms, somatic symptoms, fighting and life satisfaction[62]
Education-level, Health Seeking Behaviors	U.S. Census 2000, Michigan Counties	2007	Salmonella-Infections are higher for those with neighborhoods with lower education[63]
Adolescent Development	Neighborhoods in Chicago and Denver	1996	Neighborhood Disadvantage is associated with prosocial competence, friends and problem behaviors, juvenile delinquency and drug use[57]

Youth Violence and Delinquency	Chicago Neighborhoods	2012	Youth Violence and crime is associated with delinquency[58]

Figure 4: Model of Potential Effect Modification by Neighborhood Factors



Student Demographics: Individual Level

College enrollment rates have shown a decline in male enrollment. This is partially attributed to a decline in male high school graduation rates. In 2009, 10 million females had enrolled in college and 7.6 million males had enrolled in college.[15] The number of males enrolled in college has decreased by roughly one million from 1970. The number of females enrolled in college became higher then the number of males enrolled in college and this college enrollment gap has continued to spread over time.[15] In 2010, males were less likely to complete high school (87.4%) compared to females

(90.2%), whereas in 1975, 84.5% of males had completed high school compared to 81.8% of females.[64] The percentage of females who completed high school overtook the male percentage in 1980, and the gap has only widened.[64]

There is a gap in attainment for Black and Hispanic students compared to Whites students. In 1975, 71.1% of Blacks, 25 to 29 years of age completed high school compared to 86.6% of Whites, 25 to 29 years of age.[64] The gap has decreased slowly but still remains as 94.5% of Whites complete high school compared to 89.6% of Blacks.[64] Hispanics have the highest dropout rate (17.6%) in 2009.[64]

1.4 Innovation and Significance

Innovation

The research conducted was innovative in that it examined a key time period in a youth's educational development. This time period was whether the youth completed high school or obtained a GED by 21 years of age. This is a critical stage for young adolescents transitioning into adulthood. Our study employed an adolescent population that allowed us to follow children with chronic health conditions as they were achieving this milestone.

The dataset used also allows this study to be innovative. There are very few nationally representative adolescent datasets that have a wealth of both health and education measures. Datasets such as the National Longitudinal Survey of Adolescent Health sampled students that were currently in school whereas the National Longitudinal Survey of Youth- Cohort 1997 is a household survey that may be more inclusive of youth studied. There are youth in our survey that had already dropped out of school as well as potentially youth enrolled in the study that were in the hospital when data collectors

initially visited. Students from alternative schools including home-schooled students were captured as well. Youth with chronic health conditions may already be out of school because of the burdens of their conditions and these youth would not be captured in school samples. This makes our dataset innovative and very interesting because it may provide a more accurate representation of youth in the United States particularly youth's educational attainment and chronic health conditions compared to other datasets. Incorporating both health and education variables makes this dataset unique and ideal to test the hypotheses.

Also, this study was innovative in its examination of youth limited by and onset of chronic health conditions as well as an investigation of specific types of chronic health conditions and how they are associated with educational attainment. This study also had a robust assortment of chronic health conditions that were examined. Prior literature tends to only look at a limited number of chronic health conditions. Our chronic health conditions categories were developed from the conclusions and limitations of prior research and this provided innovation and further advanced the literature.

The social ecological model, to the best of our knowledge, has never been used to study the association of chronic health conditions and educational attainment. This model allowed us to identify contextual factors and evaluate moderators. Our model fits well into current educational literature as neighborhood, family and school factors have been shown to influence educational attainment. Although the specific framework was not used in this study, this research including effect modification and mediation can be extended to the Rumberger framework involving student disengagement. Using the social ecological model as well as incorporating epidemiology concepts to the broader

educational theory and literature that included applications to Rumberger's framework makes this research innovative.

Potential mediators and moderators have not been clearly examined in the literature for the association between chronic health conditions and educational attainment. Past literature would suggest an association between chronic health conditions and educational attainment. However potential mediation and effect modification that include: (1) academic variables such as cognitive impairment or school absences, (2) psychosocial such as psychiatric illness, (3) neighborhood and (4) school-level variables still need to be examined. This study added to the literature by exploring these different areas.

Significance of Research

There are an estimated 32 million children with a chronic health condition who are at risk for low educational attainment.[1] Childhood chronic health conditions are on the rise in the U.S., and every year more students will face problems achieving in school. Poor educational attainment has major social and health consequences. This study helped to identify predictors for youth with chronic health conditions at risk for low educational attainment and provided knowledge relevant for future strategies to keep these youth in school or to keep these students on a successful educational trajectory. This research project had important public health significance because education is a key social determinant of health. Understanding the underlying social factors that impact the health of a society helps to develop public health interventions, identify high-risk groups and develop general strategies to prevent disease.

Manuscripts Introduction

In the first paper, this study determined whether youth with types of chronic health conditions have poorer educational attainment compared to youth without chronic health conditions. This paper also explored academic, psychosocial variables and the youth's school and neighborhood environment. An evaluation of mediating academic and psychosocial factors was also conducted. In the second paper, the study determined whether youth who have early onset of a chronic health condition or are limited by their chronic health conditions have poorer educational attainment compared to youth who are not limited by chronic health conditions. This paper also explored academic, psychosocial variables and the youth's environment. The third paper identified effect modifiers in the association developed by the first paper between chronic health conditions and educational attainment.

Chapter 2: Methodology

2.1 Study Design, Data Source and Study Population

The study design used was a prospective cohort study. The cohort was formed in 1997 with 8,984 participants between the ages of 12 and 16. The youth were followed up annually and data were available through 2009. This is equivalent to 13 rounds of data collection. Out of the 8,984 participants that began the study, less than 17% of participants were lost to attrition by 2009. There were siblings included in our study from 6,819 unique households. The exposure, chronic health conditions, was determined in the baseline year (1997) and a follow up year (2002).

Data Source and Study Population

This study was a secondary analysis of one of the seven publicly available National Longitudinal Surveys (NLS design) sponsored by the Bureau of Labor Statistics.[65] The National Longitudinal Surveys have formed and collected data on multiple cohorts that include: surveys of youth (1979 cohort and 1997 cohort), a survey of older men, a survey of young men, and a survey of young women. Each of these datasets track significant life events and labor market activities such as employment, and education.[65] Our study used data from the National Longitudinal Survey of Youth – Cohort 1997 (NLSY '97).[66] The main goal of this survey is to examine youths' transition from school to work and adulthood.[65] This cohort is a nationally representative sample of 8,984 youths aged 12 to 16 born as of December 31, 1996.[65] The participants were 24 to 30 at the time of their round 13 interviews (n=7,559). Non-institutionalized households were selected across the United States from 147 primary sampling units. The dataset's

sampling design is explored in more depth in the Sampling section under Assessment of Potential Biases.

Parental and youth one-hour interviews were given in the first round (1997). Youth were asked about their early life and current history including health, academics and schooling. The youth continued to be interviewed on an annual basis. The parental and youth surveys were public use and could be downloaded by request from the NLS investigator website.[66] Although this dataset emphasized employment and education, the youths' relationship with parents, family formation, family background, alcohol and drug use, health and environmental variables were also collected through the youth and parent surveys[65]. Transcript surveys and a cognitive examination (Armed Services Vocational Aptitude Battery), substance abuse variables as well as the short form of the Mental Health Inventory (a depression scale) were also publicly available. The NLSY'97 has other surveys with restricted access that include information about the participant's school and the participant's residential community including the youth's primary sampling unit, county residence and census tract residence.

The data for the NLSY'97 were available for 13 rounds (13 years) of data collection, which is through 2009. Youth surveys asked the participant for timing and types of degrees obtained and school history including whether the participant had repeated a grade.[66] Incorporating both health variables and education variables made this dataset unique and ideal to test the hypotheses.

Exposure Variable

The exposure was chronic health conditions in childhood and young adolescence. It was operationalized by the parent questionnaire (1997) and the youth questionnaire

(2002), (Appendix: Variables Implemented). A parent was asked the following: (1) whether his/her child ever had a health condition, (2) what type of health condition, (3) when it was first noticed and (4) whether the chronic health condition limited them. A participant was asked similar questions in 2002. However these questions asked for a formal diagnosis. The original questions are below:

ORIGINAL QUESTIONS FROM 1997 PARENT QUESTIONNAIRE:[65]

Question # 1) Does [name of youth()] now have or has [he/she youth()] ever had any other chronic health condition or life threatening disease such as asthma, heart condition, anemia, diabetes or cancer?

Question # 2) What (is/are) the condition(s)? (SELECT ALL THAT APPLY.)

1 Asthma
2 Heart condition
3 Anemia
4 Diabetes
5 Cancer
6 Epilepsy
7 Other (SPECIFY)

Question # 3) How old was [name of youth ([parent calendar loop])] when the [text substitution for youth's chronic health problem or threatening disease()] was first noticed?

(ENTER "0" IF RESPONDENT HAS HAD THIS CONDITION SINCE BIRTH.)

Question # 4) Does the [text substitution for youth's chronic health problem or threatening disease()] currently limit [name of youth([parent calendar loop])]?

0 No, not currently limited by this condition
1 Yes, limited a little
2 Yes, limited a lot

The participant was also asked similar questions in 2002. They are listed below:

ORIGINAL QUESTIONS FROM 2002 YOUTH QUESTIONNAIRE:

Question # 1) Have you ever been diagnosed with any other chronic health condition or life threatening disease such as the ones listed on this card?

Question # 2) What conditions have you been diagnosed with?
(SELECT ALL THAT APPLY)

1 Asthma
2 Cardiovascular or Heart condition
3 Anemia
4 Diabetes
5 Cancer
6 Epilepsy
7 HIV/AIDS
8 Sexually transmitted disease other than HIV/AIDS
9 Other

Question # 3) How old were you when the [chronic condition] was first diagnosed?
(INTERVIEWER: ENTER "0" IF RESPONDENT HAS HAD THIS CONDITION SINCE BIRTH.)

Question # 4) Does the [chronic condition] currently limit your activities?

1 Yes, limits a little
2 Yes, limits a lot
0 No, not currently limited by this condition

These questions served as measures for type (paper 1, 3) and onset of chronic health conditions (paper 2) as well as whether the youth is limited by chronic health conditions (paper 2).

In paper 1, we first examined whether the participant ever had a chronic health condition. We used question #1 (above) from both the 1997 and 2002 surveys. The correlation between each of these surveys for question 1 is r=0.34. When new 2002 chronic health cases were excluded from this analysis, the correlation is r=0.67. If a participant reported that they had a chronic health condition at either of these times then that would be recorded as “Ever having a chronic health condition”. If the participant reported that they did not have a chronic health condition during both of these times this would be recorded as “Never reporting a chronic health condition.” This variable was used for the overall chronic health condition analysis in paper 1.

Chronic health conditions were also categorized for analysis by type in paper 1. We used question #2 from both the 1997 and 2002 surveys. We excluded specific diseases based on chronic health condition criteria from Mokkink et al.[13] These researchers developed a definition of childhood chronic health conditions for epidemiologic studies. Based on this definition, the conditions that we applied to our study were that: (1) disease is (yet) curable and (2) the disease has been present for longer than three months, will probably last longer than three months, or has occurred three times or more during the past year and will probably recur again. Those participants that reported anemia, infectious diseases, sexually transmitted diseases other then HIV/AIDS, and allergies were not considered chronic health conditions for our categorized analysis.

We created four main categories: (1) asthma, (2) cancer, diabetes or epilepsy, (3) heart or cardiovascular condition and (4) other. Asthma had a separate category because of the past literature which has determined asthma has better educational attainment outcomes compared to non-asthmatic chronic health conditions (cancer, diabetes or epilepsy). Cancer, diabetes or epilepsy has been used as a category in past literature. Also, we created this grouped category because the prevalence for each of the chronic health conditions was small and limited. A chi-square test on each condition was performed. This showed that each was similarly associated with poor educational attainment. Heart or cardiovascular conditions had the largest prevalence out of the other chronic health conditions. This allowed it to have its own separate category. The final category, other, grouped together the rest of the chronic health conditions.

There were participants that reported multiple chronic health conditions (6% of the sample). These were categorized based on which condition has the highest effect on a

person's educational attainment from previous literature. If a participant reported more than one non-asthmatic condition they were categorized based on general disease severity. For example, if a participant reported having cancer, diabetes or epilepsy and a heart condition this participant was categorized into the cancer, diabetes, or epilepsy category.

In paper 2, we identified participants that were limited by their chronic health condition as well as early onset of their chronic health condition. We employed question #3 for those limited by a chronic health condition and #4 for early onset of the chronic health condition from the 1997 and 2002 questionnaires. If a participant reported that they were "limited a little" or "limited a lot" by the condition then they were classified as being limited by a chronic health condition. These were combined due to small prevalence for each individual response. If a participant reported not having a chronic health condition at both times, they were considered "never reporting a chronic health condition."

Age at onset was measured by when the condition was first noticed in 1997 and first diagnosed in 2002. The earliest age that was reported from either survey was used to describe age at onset. A response of "0" was used to describe participants that were born with the condition. We first conducted a univariate analysis on this variable. We determined that the mean age at onset was near 8 years of age. The 75^{th} percentile was 12 years of age. After examining the distribution of onset, we realized that 12 years of age is near completion of elementary school and start of middle school. This seemed to make a sufficient cut-off period for early onset. We believed that a cutoff of 8 years of age might be too young to describe early onset. Further analysis showed that having 8

years of age as the cutoff obscures the effect of early onset versus later onset. We examined onset at later ages as well but this was categorized as later onset. We also excluded the following conditions from our paper 2 analysis: allergies, anemia, sexually transmitted diseases other than HIV/AIDS, and infectious diseases. This was done similarly based on the chronic condition consensus definition discussed earlier.

In paper 3 we used similar exposure measures (overall and type) as in paper 1. We classified and categorized our chronic health variables similarly using question #1 and question #2 from 1997 and 2002. These measures were then examined among different modification levels from the neighborhood, family and school.

Dependent Variable: Outcome

In this study, the outcome was operationalized by high school or GED completion by 21 years of age assessed from the youth surveys. In each round that the participant was followed, they were asked whether and when the participant had received a high school diploma or obtained GED. Survey staff developed cumulative measures that identified when a high school diploma or GED was received in cumulative months.

Cumulative months start in the first month that the earliest participants were born; January 1980. Months are counted from January 1980 onward for the rest of the study. We first developed a unified measure for obtaining a GED or high school diploma completion in cumulative months. In the event more than one GED was reported then the earliest month reported was used. The end product had each participant's high school diploma or GED completion in cumulative months.

In order to determine the age that each participant completed his or her high school or GED, we converted the participant's age at baseline (in 1997) into cumulative

months. For example, if a participant were born in February 1981, then this would be recorded as 14 cumulative months. After converting participant's age into cumulative months, this number was subtracted by the participant's high school or GED completion in cumulative months.

This resulted in a measure that calculated the age (in months) each participant was when they received a high school diploma or GED. When the participant is 252 months old, the participant is 21 years old. Consequently, if the participant reported having completed their high school degree or GED by less than or equal to 251 months then they would be classified as "Completed a High School Diploma or a GED By 21 Years of Age." If the participant did not complete a high school diploma or a GED by 251 cumulative months then they would be classified as "Not Completing a High School Diploma or a GED By 21 Years of Age."

A similar outcome had been previously incorporated in a study using the NLSY '97.[27] In this study each participant had a measure that integrated the specific month during the study he or she had received a high school diploma or obtained a GED.

Control Variables – Core Variables

The following control variables were assessed at baseline (1997) and were used throughout the analyses: (1) participant's age, (2) participant's gender, (3) participant's race/ethnicity, (4) parent's education. These variables have been included in the past literature to estimate the association of heath or chronic health and educational attainment that also used nationally representative U.S. populations. Each variable was also associated with the outcome based on the bivariate analyses (see Analysis section). A participant's age in 1997 was determined from both the month and year the participant

was born. As explained above, this was converted into cumulative study months. This cumulative month measure was used to assess a participant's age. Age was later converted from months to years for sample descriptive statistics. A participant's gender was assessed in 1997 from whether the sex of the participant was male or female. The dataset already had created dummy variables for (1) male and (2) female. Race/ethnicity was classified by survey staff as: (1) Hispanic, (2) Black- Non-Hispanic, (3) Mixed Race-Non-Hispanic and (4) Non-Hispanic and Non-Black. There were separate 1997 race and ethnicity questions but this variable incorporated these questions as well as household oversampling data and parent's background. The fourth category, Non-Hispanic and Non-Black, contained 94% participants that reported they were Non-Hispanic White. Every other racial category that was neither Hispanic nor Black (Asian, Alaskan, other) was also included in this category. Only one percent of the sample reported having Mixed Race – Non-Hispanic. This group was collapsed into the Black- Non-Hispanic category for analysis purposes. The highest grade that the mother or father completed were used to operationalize parent's education level. The parent's survey interviewed one of the child's parents in 1997. This parent was asked what the highest grade that the biological father and biological mother's education achieved irrespective of whether those parents were currently living with them or not. This variable was recorded on a scale from 0 (no education) to 20 (8 years of college or more).

Control Variables - Other Potential Confounding Variables

Other potential confounders included youth with learning disabilities, household income, household wealth and 2-parent household. Past literature has shown an

association with these variables and educational attainment.[27] Each variable may serve as a confounder in the association with chronic health exposures and educational attainment.

A learning disability is defined by the Learning Disabilities Association of America as "a neurological condition that interferes with a person's ability to store, process, or produce information" and can "affect one's ability to read, write, speak, spell, compute math, reason and also affect a person's attention, memory, coordination, social skills and emotional maturity."[67] These learning differences do not affect a person's ability but may impede their educational achievement and educational attainment. Students with learning disabilities were involved in preliminary analysis for models as potential confounders.

Having a 2-parent household plays a role in the educational attainment of a child. This variable was controlled for in past analyses of self-reported health and educational attainment[27]. Students that do not have a 2-parent household may be an important indicator of family instability and stress on the family. This does not exclude dysfunctional 2-parent households from providing stress to the family. However single parent households have one less wage earner and may represent an added burden that the family and child with a chronic health condition must further overcome.

We have mentioned above that past literature has shown an association with poverty and poor educational attainment. This variable was controlled for in past analyses of self-reported health and educational attainment.[27] Consequently, household income and household wealth were also involved in preliminary analysis for model selection as potential confounders. In the model specification section, we discuss how each control variable was examined for addition to the models.

Neighborhood Factors

Neighborhood factors were first assessed from the county-level and we were later able to acquire data on the census tract-level. A geocoded disc allowed access to county-level residence for each participant in 1997. County-level variables were obtained from SimplyMap and Census 2000 data.[68,69] These numbers were combined into an EXCEL dataset and this aggregated information was imported into ArcMap. A SAS dataset of the county that each participant resided in 1997 and each participant's ID were exported into a .dbf file, and imported into ArcMap. The files in ArcMap were merged together and the final product was a spreadsheet of the participant's ID, their 1997 county of residence and their county-level neighborhood variables. Finally, this county-level neighborhood file was imported into SAS.

We were able to secure onsite access at the Bureau of Labor Statistics in Washington, DC. This provided us with the participant's census tract residence in 1997. We were able to have census tract estimates by merging Census 2000 information and a student location data using SAS 9.1.[68] All of our reported analysis used census tract information. This census tract-level provided a better estimate of the neighborhood compared to county-level. We determined the SimplyMap data had insufficient material for the census tract level and we were unable to use it for the subsequent analysis.[68,69] We tried the county-level SimplyMap information in census tract analysis and these variables were not selected for our final model.[69] Our selection methods for neighborhood variables are discussed in depth in Section 2.5: Model Specification.

Neighborhood county-level variables included: (1) neighborhood income, (2) neighborhood education, (3) neighborhood race/ethnicity, (4) EASI murder index, (5)

EASI Total Crime Index, (6) medical access and (7) aggravated assault index. Neighborhood census tract-level variables included: (1) neighborhood income, (2) neighborhood education and (3) neighborhood race/ethnicity. Neighborhood education was measured by the percentage of people 25 years and older in the area with less than a high school degree from the U.S. Census 2000 for the county and census-tract level. Neighborhood income was measured by the median income in the neighborhood from the U.S. Census 2000 on the census tract and county level. Finally, neighborhood race/ethnicity was also analyzed from the U.S. Census 2000 for the county and census-tract level. Each of these variables was analyzed continuously. When we only had county-level data available, none of the neighborhood variables were selected in our forward selection (see Analysis) so we also tried categorical variables as well. Crane et al suggested that there may be a neighborhood tipping point for dropping out of school.[59] High and Low groups were created for neighborhood education based on the sample mean. This allowed us to have two groups with similar sample size. However we do use county-level variables in our final analysis. All census tract neighborhood variables were examined continuously.

School Factors

Onsite access also allowed us to use the National Longitudinal Survey of Youth - school surveys. School-level variables were assessed from the school surveys and one question from the 1997 youth surveys. In 1996, the National Opinion Research Center (NORC) developed school surveys. All schools that had a 12th grade were surveyed from the study's 147 primary sampling units. Eligible schools were determined by a commercial database. Surveys were sent to the principal that contained a series of

questions about the school. If the form was not sent back, a short form was sent to the principal of these schools. These forms asked slightly different questions. A follow up survey was sent out in 2000 for the original school as well as additional schools the participant had attended. This form asked different questions as well.

We created school variables using both the long and short form of the 1996 school survey and the 2000 school survey at the Bureau of Labor Statistics. If the school did not report a value for 1996, then the 2000 value from the school was used. For many variables, the 1996 school survey required calculation of percentages whereas the 2000 school survey had reported percentages from the principal. If our calculated percentage was over 100 hundred percent, then this would be considered missing. The dataset was linked to the school that each participant attended in 1997. If there was no school data available, the next school the participant attended was used instead. The school level variables were categorized by school characteristics, teacher characteristics, and school environment.

School characteristics included (1) school type, (2) class size, (3) length of school year, (4) length of school day, (5) school race/ethnicity and (6) percentage of Limited English Proficient students. School type from the 1997 youth surveys was categorized as: (1) public school, (2) private and parochial school, and (3) other. For the school surveys, school type was categorized as: (1) public school and (2) private school. There were multiple categories for school type in the school surveys. However due to small sample size, we needed to collapse these categories into a binary category. Class size was constructed from the number of teachers in the school divided by number of students reported in the school. Length of school day (hours and minutes) and length of school

year (days) were determined. If the principal reported the number of hours but not the number of minutes, then only the number of hours was used. The percentage of Non-Hispanic Whites, Blacks and Hispanics were used to assess school race/ethnicity. The percentage of Limited English Proficient students was also used.

Teacher characteristics included: (1) teacher experience, (2) teachers with advanced degrees and (3) 5-year teacher turnover. The number of teachers with 10 or more years of experience divided by the total number of teachers at the school was used as the assessment of teacher experience at the school. Similarly, the percentage of teachers with advanced degrees was assessed by the number of teachers with beyond a bachelor degree divided by total number of teachers.

The school environment was categorized into 3 different areas: (1) academic environment, (2) social environment and (3) affective environment. The academic environment was measured by: (1) percentage truancy, (2) percentage tardy and (3) SAT/ACT scores. The percentage of students that were tardy had a lot of missing values and was not used as a measure of the academic environment in the analysis. A variable was created for youth schools that reported average SAT and ACT scores that standardized the ACT score to SAT scores from the Princeton Review.[70] If both values were reported then the SAT scores were used. Percentage truancy was measured by the percentage of reported students truant at the school.

The social environment was measured by: (1) possession of alcohol or drugs, (2) students under the influence of alcohol or drugs and (3) school conflicts and teacher abuse. The reported percentage of students that possessed alcohol or drugs was assessed by two separate questions: (1) percentage of students that possessed alcohol and (2)

percentage of students that possessed drugs. The maximum percentage that was reported for either of these questions was used. The percentage of students under the influence of drugs and alcohol was a variable that was created as well, but this variable had a lot of missing values because it was not asked in the 2000 questionnaire. School conflicts and teacher abuse also had too many missing values. The amount of abuse or conflicts at the school was also assessed by the combined amount of verbal and physical abuse of teachers as well as the number of conflicts. The percentage truant was also be used to represent the social environment as well. The affective environment was measured by: (1) curriculum involvement of teachers, and (2) curriculum involvement of parents. The principal rated the involvement on a scale from 1 to 4. Both of these variables also had a lot of missing values, and neither was asked in the 2000 survey.

The school dataset with the created variables was then linked to the participant's identification number by the school they attended in 1997. Nearly half of the participants had missing values for school level information. To increase sample size, if the participant attended a school in 1997 that did not have available information, then the next available school the participant attended was used (until 2004). In the final analyses, a model that kept only the 1997 school attended subjects as well as a model with the added school values yielded very similar results and trends. The variables: percentage tardy, curriculum involvement of teachers, curriculum involvement of parents, school conflicts and teacher abuse, students under the influence of drugs and alcohol were removed from the analyses due to sample size considerations. We also removed the 1997 youth survey's school type variable from the final analysis. Our initial models kept this variable, but when we obtained onsite access at the Bureau of Labor Statistics, we were

able to access and use in our final analyses the principal-reported school surveys measure of school type. The youth survey had more observations including the "Other" category that may include alternative schooling. Analysis showed this variable produced similar results as the school survey's school type binary variable.

Below is a list of variables that we initially created for the school and neighborhood dataset. In Section 2.5: Model Specification, we discuss the selection methods for school and neighborhood variables into our model.

Table 3: Measures Implemented In NLSY'97 for School and Neighborhood

Type	Obtained From	Category	Variables Measured	Responses
Neighborhood	**Geocoded Disc (county - level)**	**Crime**	**Murder Index, Total Crime Index and Aggravated Assault Index**	**Easy Analytic Software Inc. Scales, SimplyMap**
Neighborhood	**Geocoded Disc(county-level), onsite (census tract-level)**	**Education**	**Percentage with Less then high school degree**	**Census Tract 2000 Percentages**
Neighborhood	**Geocoded Disc (county-level)**	**Medical Access**	**Medical Index**	**Easy Analytic Software Inc. Scales, SimplyMap**
Neighborhood	**Geocoded Disc(county-level), onsite (census tract-level)**	**Income**	**Median Household Income in 1999**	**Census 2000 in $**
School	**School Surveys**	**Type**	**School Type**	**Private, Public**
School	**School Surveys**	**Type**	**Length of School Year and Day**	**Year: Days, Day: Hours, Minutes**
School	**1997 Youth Surveys**	**Type**	**School Type**	**Public, Private and Parochial, Other**
School	**School**	**Type**	**English - Second**	**Percentage in**

	Surveys		**Language**	**English as a Second Language program**
School	**School Surveys**	**Type**	**English - Second Language**	**Percentage as Limited English Proficient**
School	**School Surveys**	**Type**	**Race/Ethnicity Composition**	**Percentage Non-Hispanic White, Black, Hispanic**
School	**School Surveys**	**Type**	**Class Size Estimate**	**Number of Students Enrolled in School / Number of Teachers**
School	**School Surveys**	**Quality of Teaching**	**Teacher Experience**	**Teachers with 10 or more years experience/ Number of Teachers**
School	**School Surveys**	**Quality of Teaching**	**Teachers with Advanced Degrees**	**Teachers with beyond Bachelor Degree/ Number of Teachers**
School	**School Surveys**	**Quality of Teaching**	**Teacher Turnover**	**Teachers who taught five years ago/ Number of Teachers**
School	**School Surveys**	**Environment**	**Overall Environment**	**Percentage of students tardy on a typical day**
School	**School Surveys**	**School Environment**	**Overall Environment**	**Percentage truant on a typical school day**
School	**School Surveys**	**School Environment**	**Academic Environment**	**Average ACT/SAT scores for 1996**
School	**School Surveys**	**School Environment**	**Academic Environment**	**Credits Required for Graduation**
School	**School Surveys**	**School Environment**	**Social Environment**	**Percentage of students under the influence of alcohol, illegal drugs**
School	**School Surveys**	**School Environment**	**Social Environment**	**Number of Physical Conflicts Among Students during year**
School	**School Surveys**	**School Environment**	**Social Environment**	**Number of Physical and Verbal Abuses of Teachers**
School	**School Surveys**	**School Environment**	**Affective Environment**	**1 to 5 Scale, Parents Involved in Curriculum and**

				Evaluating Teachers
School	**School Surveys**	**School Environment**	**Affective Environment**	**1 to 5 Scale, Teachers Involved in Curriculum**
School	**School Surveys**	**Student Mobility**	**Student Movement**	**Number of Students Enrolled or Left School During the Year/Total Number of Students**

Continuous and Categorical Variables

Initially each numeric school variable used in the analysis was kept continuous. These variables were constructed both categorically and continuously. Two numeric variables were changed to categorical: percentage of non-Hispanic Whites and percentage of teachers with advanced degrees. It was believed that higher or lower percentage categories better characterized these groups. Nettles et al examined racial composition and academic achievement in school and used higher or lower groups (in terms of high or lower percentage of Whites).[55] Our study examined the cumulative frequencies of this school variable. The unweighted mean was used as the reference to determine the categories. This allowed us to have a similar number of subjects in each group for analysis. Percentage of teachers with advanced degrees was also incorporated as a categorical variable. Analyzing this variable continuously gave us odds ratios that were all close to 1.00. This was a reflection of very small reported percentage changes. We added this variable categorically because we wanted to better display the effect including directionality of the association with poor educational attainment. The mean unweighted percentage was used as the division between higher and lower groups. This ensured that each group had comparable size. Paper 1 and paper 2 analyses incorporated these variable classifications.

For paper 3 we evaluated effect modification. Higher or lower groups for numeric variables were categorized for stratification. The mean of the sample was used to keep comparable sample sizes among each strata. For example, percentage truancy was categorized into a higher group and a lower group based on the sample mean of 3.93% truancy.

Individual level Academic and Psychosocial Factors

Academic variables included cognitive score, grade point average, school absences and whether the participant had repeated a grade (For list refer to the Appendix: Variables Implemented). These data were accessed from a cognitive examination, student transcripts and self-reported surveys. Psychosocial variables were also investigated. These variables included depressive symptoms score measured by the Mental Health Inventory-5, a depression scale, as well as self-reported substance abuse, and whether the participant felt safe at school or was a victim of bullying. All of these potential mediating variables were used in paper 1.

The final models separately added academic, psychosocial, school and neighborhood variables. Paper 1 included each academic and psychosocial variable with the exception of youth who repeated a grade in the model. Based on sample size restraints from our other chronic health measures, we did not include victim of bullying, cognitive score and number of absences in paper 2. For youth limited by a chronic health condition, we only used youth who repeated a grade. Youth who repeated a grade and high school grade point average were used for both early onset of a chronic health condition and youth limited and had early onset of a chronic health condition. Cognitive score and number of absences acted very similarly to grade point average in these

analyses models. Victim of bullying did not have a significant effect on educational attainment and was the only psychosocial variable that was not included in our paper 2 models. Academic and psychosocial variables were not included in paper 3.

Cognitive score was assessed from the Computer Assisted Technology – Armed Services Vocational Aptitude Battery (CAT- ASVAB).[71] In 1997 or 1998, the examination was administered to participants. The validity and reliability of this instrument has been widely studied on many populations.[72] There were four sections that included: (1) mathematical knowledge, (2) arithmetic reasoning, (3) word knowledge and (4) paragraph comprehension. An exhaustive review by Welsh et al examined the content, criterion, and construct validity for the ASVAB.[72] One of the validity studies incorporated the NLSY'97 population. Each section of the examination has good content validity. The CAT-ASVAB has an overall estimated reliability of 0.97.[72]

Aggregate Verbal and Math scores were computed. An overall score that includes all sections of the ASVAB is known as the Armed Forces Qualification Test (AFQT) score. This score incorporates weights and percentiles based on the general U.S. population. However, an AFQT score was not assigned for this dataset because it was assumed that the young NLSY'97 population would not be properly represented with these weights.[60] However, an overall percentile score ranging from 0 - 99 was developed for the National Longitudinal Survey of Youth – Cohort 1997. This score was constructed with very similar methodology as the AFQT score. Sampling weights based on age of the participant were applied.

Participant's grade point average in high school was assessed from high school transcripts. In 2000, transcripts were collected for the oldest participants initially. In

2004, transcripts were collected for all participants including participants that were missing transcripts from the first data collection. The overall GPA was used for this study. This measure also incorporated the quality of the credits using the Carnegie Weighting System.[59] This method gives a higher weight to higher quality credits. The GPA scores ranged from 0.0 (Lowest) to 5.0 (Highest).

Absences from school were assessed from transcripts and the self-reported surveys. In 1997, participants were asked to report the number of absences that they had during the last fall term. We also used absences from the transcript surveys from the 1999, 2000 and 2001 school years. The maximum number of reported absences from either source was used. Self-reported information was also incorporated because there was limited absence information from the transcripts. However, this measure allowed us to give the transcripts more influence because of the longer time periods assessed on the transcripts. If a participant's absences from school were missing from transcripts then the self-reported survey was used.

Youth that repeated a grade was assessed from a cumulative measure that survey staff created from the youth surveys. This variable included any repeated grades from elementary school, middle school and high school. We initially collapsed this measure into "Repeated 2 or More Grades", "Repeated 1 Grade" and "Never Repeated a Grade." A binary variable was primarily used in the analyses that categorized the measure further into "Ever Repeated A Grade" and "Never Repeated A Grade."

Depressive symptoms score was assessed from the Mental Health Inventory – 5 (MHI-5, short form).[73,74] This short form contains 5 questions and is used as a quick screener for depressive symptoms.[74,75] This inventory has a Cronbach alpha of 0.82.[73,76]

The Mental Health Inventory forms were designed by the National Health Insurance Study to evaluate mental health issues such as anxiety, depression, behavioral control, positive effect and general distress.[73] This instrument helps in the measure of overall emotional functioning. The MHI-5 has shown good convergent and discriminant validity for mood disorders.[73] The long and short forms of the Mental Health Inventory were not developed to be a formal diagnostic instrument for depression. This inventory was administered biennially from 2000 to 2008. Our depressive symptoms variable used the 2000 inventory but if any of the responses to the questions were missing, the 2002 responses were added (n=398 cases).

The original 5 questions and responses of the Mental Health Inventory-5 from the National Longitudinal Survey of Youth – Cohort 1997 are listed below:

(1) How much of the time during the last month have you been a very nervous person?

1 All of the time
2 Most of the time
3 Some of the time
4 None of the time

(2) How much of the time during the past the last month have you felt calm or peaceful?

1 All of the time
2 Most of the time
3 Some of the time
4 None of the time

(3) How much of the time during the last month have you felt downhearted and blue?

1 All of the time
2 Most of the time
3 Some of the time
4 None of the time

(4) How much of the time during the last month have you been a happy person?

1 All of the time
2 Most of the time
3 Some of the time
4 None of the time

(5) How much of the time during the last month have you felt so down in the dumps that nothing could cheer you up?

1 All of the time
2 Most of the time
3 Some of the time
4 None of the time

These questions were scored from 1 to 4 as shown above. Questions 2 and 4 were reverse scored. These questions' scores were added together yielding an overall range of 5 – 20. This score was transformed to reflect a 0 – 100 scale similar to past studies.[72] We used this equation:[77,78,79]

$$\text{Transformed score} = \frac{(\text{Raw score} - \text{Minimum possible raw score})}{\text{Possible raw score range)}} * 100$$

Transformed score = ((Raw Score – 5) / 15) * 100

A higher score indicated more depressive symptoms. There have been studies examining cutoff points for the Mental Health Inventory – 5 that are suggestive of depression but none have been widely accepted.[77,78,79] Although we never intended to measure depression with this instrument, we replicated some of these cut-off points. Applying these cutoffs to our study produced only a small percentage of participants as having depression. A diagnosis of depression may not be appropriate for our adolescent population.

Substance abuse was assessed from the 1997 youth survey. This survey asked if participants ever used many types of drugs. The following three questions were incorporated into our measure: has the participant ever smoked, has the participant ever

drank and has the participant ever used marijuana? We categorized our measure into the following categories: (1) if the participant reported using all three, (2) reported using any of them but not all three or (3) reported using none of the above. We used the "ever" measures because this is a young adolescent population where initiation for any of these drugs is more important then cumulative usage. As participants used more types of drugs, there was a gradient increase in the number of participants with poor educational attainment.

Responses on a 4-point Likert scale from the 1997 youth survey assessed whether participants felt safe at school. Responses ranged from "strongly agree" to "strongly disagree." Haas and Fosse assessed those that felt safe at school in the same manner.[27]

Variable Selection Hypotheses

Along with the theoretical framework and literature review, a determination of the variables for modeling was considered. The dataset offered an abundant number of variables. A three-tier list of importance of variables was created which looked at: core variables, principal variables and other variables. Core, principal and other variables were based on the past literature, theory and past models of chronic health conditions and educational attainment. This assignment of variables was useful when identifying variables for our model but was later evaluated with the confounder analysis and elimination analysis of school and neighborhood factors (See Section 2.5 Model Specification). Academic and psychosocial mediators were added from the health and educational literature.[27]

The Maslow article on chronic health conditions and educational attainment used the AddHealth dataset.[8] This paper provided a model to start determining my core

variables. The variables that were used in this study's model were age, sex, race/ethnicity and parent educational level. These variables were included in my model as essential variables.

The Haas and Fosse article on self-reported health and educational attainment used many types of variables from the National Longitudinal Survey of Youth dataset.[27] These variables were participant's gender, participant's age, participant's race/ethnicity, household income, household wealth, mother's education, father's education, 2-parent household, learning disability, household income and household wealth. The variables included in Maslow et al's study were also included in the Haas and Fosse study.[8,27] This gave more credence to Maslow et al's list of variables.

As we have discussed earlier the Haas and Fosse study also had academic and psychosocial variables that we will evaluate as potential mediators in our study. All these variables could aid in my study. However, there may be some overlap in variables such as household income and household wealth. More variables that may overlap are grade point average and ever repeated a grade. Our multicollinearity analysis was used to examine all variables added to our study and whether they contributed to multicollinearity (See Sections: Multicollinearity and Correlation Analysis).

Neighborhood and school factors were also assessed in this study. It is important to explore the level of influence that the neighborhood's education has on the association of chronic health conditions and poor educational attainment. Other neighborhood level variables in our principal group (Tier 2 category) were examined and included neighborhood race/ethnicity and neighborhood income. It was also important to explore the amount of influence that the neighborhood's race and neighborhood's income has on

the association of chronic health conditions and poor educational attainment. Other neighborhood variables previously explained were examined and were in our Tier 3 category.

School factors that were examined are based on the most significant factors from the educational literature. From our literature review, studies conducted addressed many important variables. However it was difficult to determine the best indicators from the literature because many of the studies examined different variables from different levels of analyses. Schools from separate states or localities were investigated, and there were a lack of standardized measures for variables from the school environment, and teaching quality.

School factors for high school that appeared to have the largest effect and relevance to our study are school type, class size and teacher's experience. These variables were relatively standardized in the literature and have also been shown to be very influential to a student's achievement and development. School variables may also be related to the association of chronic health conditions and educational attainment as well. Youth with a chronic health condition's achievement could potentially be affected by teacher experience. The teacher may have experience with students with similar difficulties and may have developed ways improve their participation, progress, and achievement.

School type was important to our study since the literature has shown that certain private schools help reduce dropout rate.[41] Private schools are shown to have better math and reading scores compared to public schools with scores becoming more disparate in 8th grade compared to 4th grade adjusting for other factors.[42] Class size was another

principal variable added to our study. Teachers can give students with chronic health conditions more attention that may affect their educational achievement. However these variables were further investigated from the preliminary forward analysis to determine if it should be included in the model. More recent studies note that small classes were more important in the initial stages from kindergarten to 3rd grade and the importance decreases in secondary school.[51,80]

Overall, the list of variables and categories provided an initial hypothesis of the potential importance of these variables (See Appendix for Categories). The model specification section provides the detailed selection and evaluation of these variables. In our conclusion section (Chapter 6), we address how different these variable selection hypotheses were compared to our results.

2.2 Assessment of Potential Biases

Sampling

This study was an analysis from a nationally representative sample. A complex multi-stage sampling design was used. Participant's households were selected from 147 primary sampling units in the United States. The sample was developed to represent the civilian, non-institutionalized population of U.S. youths 12-16 years of age as of December 31, 1996.

Two subsamples were developed: (1) a cross section of people born from January 1, 1980 to December 31, 1984 living in the United States in 1997 and (2) a supplementary group that oversampled Hispanics or Latinos and Blacks living in the United States in 1997 and born during the same time as the other subsample. Housing units were determined for screening through systematic sampling, an efficient form of

random sampling. Random sampling avoided selection bias and provided representativeness of the U.S population. Field researchers visited areas selected within the 147 primary sampling units. Screening interviews determined which housing units had eligible populations for the main interviews. Youth participants that were currently staying at a general hospital were also considered eligible. This survey design allowed for a nationally representative sample with customized weights, clusters, and strata.

Loss to follow up from this study may cause a selection bias, as youth who do not complete the study may be different than youth who are still engaged in the study. We are also not certain if youth missing from the rest of the study completed high school or a GED. However, this study has a very good participant retention rate (less than 17% attrition by Round 13). The basic analytic sample's average follow up is over 10 rounds. A comparison of the overall sample versus the analytic sample shows that each is very similar in terms of all variables in our models.

Analytic Samples

In our first manuscript the analytic sample was n=6,795. From the initial sample of 8,984, there were 8,849 participants that had a cumulative value for our educational attainment measure. This information was obtained from the youth surveys. This number was further reduced based on the number of participants who were included in our chronic health measure (n=7,196). This number was also reduced from the number of participants with a reported parent's education (n=8,503). Based on these missing values for each variable, the analytic sample for our final model was n=6,795.

In our second manuscript we also start with 8,984 participants in which 8,849 participants had a complete case for our educational attainment measure. Out of these

participants, 7,134 participants reported values for our onset measure and 7,098 participants reported whether they were limited by a chronic health condition. In addition, there were 8,503 participants that had a parent's education. Our final model's analytic sample was n= 6,738 for onset and n=6,701 for our limited measure.

Finally, our third manuscript followed a similar path as the first manuscript. We used the same chronic health measure in both manuscripts. However, we also implemented an additional step in which we added school and neighborhood factors. Overall the final analytic sample for the third manuscript was n=3516.

Missing Data Analysis

This analysis used data from only complete cases. There were several missing values from the school and neighborhood-level analyses (n=3339). This large number of missing values was mostly due to missing school-level information. Bivariate analyses (chi-square or t-test) were conducted that determined differences between the analytic samples in the manuscripts and missing school values based on the exposures and confounding variables used. The exposure, and variables 2-parent household and gender of the participant in the analytic sample were not significantly different compared to the exposure and variables 2-parent household and gender from the missing values.

However, the bivariate analyses showed that missing values for the variables parent's education, race/ethnicity and age of the participant were significantly different compared to the analytic sample. Parents in our analytic samples were more educated, had less Blacks and Hispanics and were older compared to missing school samples. This does bias our school sample to have more educated parents (by less than half of a grade) and comprised of older participants (by 14 months) for all manuscripts. Our sample was

also more Non-Hispanic, Non-Black by near 3 percent. The age of the participants was significantly different because younger participants may not be old enough to attend a school with a 12th grade in 1997. We tried to correct this by adding the next school the student attended if the 1997 school was unavailable. These differences are statistically significant but are still very similar. In addition we conducted a logistic regression that recreated our final model with only missing school and neighborhood values. We found that the odds ratio that was generated was similar to our analytic sample's odds ratio in the first manuscript. For the second manuscript, the odds ratios were similar for age at onset when we compared our neighborhood and school onset model to a model containing only missing neighborhood and school values.

When we conducted a similar comparison for the variable, limited by a chronic health condition, the missing school and neighborhood values had a lower odds ratio for poor attainment compared to our limited model suggesting that our final school and neighborhood model slightly overestimated this association. Based on partially on these findings, we displayed two school models in our final analysis for those limited by a chronic health condition. The first model did not include the variable percentage truancy and the second model included all school and neighborhood variables. This allowed us to present a model with fewer missing values. The model without the variable percentage truancy had a very similar odds ratio to our basic model and the final model had a slightly higher odds ratio compared to the basic model. Regardless, our main findings from the school and neighborhood in the second manuscript were based on the onset variable as opposed to the limited variable.

We also did analysis on our other missing values. Our initial analytic sample had a sample size of 6,795 out of the 8,984 participants. This was close to 80% of the full sample. Many of these values were missing from the chronic health surveys. Bivariate analyses comparing the difference between the analytic sample and this missing data revealed the exposure, and the variables 2-parent household and gender are not statistically different. However the variables, parent's education and age were significantly different in our bivariate analyses. Overall, our initial samples were biased for more educated parents (by a quarter of a grade) and comprised of younger participants by 3 months.

Academic and Psychosocial Variables

Most of the academic and psychosocial variables had relatively few missing values based on the general inaccessibility of some of these objective measures including grade point average, cognitive score, depressive symptoms score and absences from school. This was partly due to the way these variables were developed (Section 2.1). Out of the academic variables, those that repeated a grade had the lowest amount of complete values (n=5943). This variable was initially not used when we first added academic variables in paper 1. This was done partially because it was correlated with some of the other academic variables (cognitive score: r=-0.39 and grade point average: r= -0.30) but it was also because we did not want to have more missing values in our model. In paper 1 and paper 2, we had several different models that added different combinations of academic and psychosocial variables together as well as certain models that added these variables individually. These models showed similar effects. In paper 2, our chronic health exposures (limited by and onset of) had smaller sample sizes, so we

did not include some psychosocial and academic variables that we have included in paper 1. Missing data analysis for paper 1 and paper 2 for academic and psychosocial variables show that the amount of each exposure is similar across missing values and the analytic sample (See Appendix). For each pathway of the mediation analysis, the sample size was restricted to only the complete case subjects in the final pathway where exposure and mediator were both added in the model.

Misclassification

Misclassification of the exposure or outcome can be problematic in a study. Chronic health conditions as an exposure can be difficult to measure due to their dynamic nature, including differences in the overall definition of chronic conditions. In our study, we reduced the misclassification error by defining chronic health conditions based on whether the participant ever reported having a chronic health condition from two different time periods (1997, 2002). However, this did not include participants that develop a chronic health condition after 2002. These measures were entirely based on self-reported (2002) or parent-reported (1997) surveys that may be subject to measurement error. We are not implementing any objective test or receiving medical records to prove that these participants had chronic health conditions. As shown above from the original questionnaires, these surveys are asking slightly different questions. The 1997 parent survey asked if the participant ever had a chronic health condition. The 2002 youth survey asked if the participant was ever diagnosed with a chronic health condition. These capture different chronic health participants. These differences in the questionnaires subject the youth to exposure misclassification. In 2002, participants that have developed a chronic health condition but who did not seek health care would not be

counted as having a chronic health condition. After univariate analysis, we found that there were more participants that had a chronic condition in 2002 compared to 1997. This seemed reasonable as the youth are older. Univariate analyses also revealed percentages for specific types of chronic health conditions, such as asthma and cancer, that were similar to prior childhood and adolescent chronic health condition literature[8].

We also tried to improve upon our categorization of exposure by implementing a prior consensus definition for chronic health condition used in Mokkink et al and the variable that asked respondents to delineate the type of chronic health condition reported.[13] This framework allowed for a potential improvement to categorizing our exposure. Both the initial classification of chronic health condition as well as the updated categorization was implemented in our analyses. We also examined different measures that included type of, youth limited by, onset of and youth limited and having early onset of chronic health conditions measures to better understand the association of many chronic health condition measures on poor educational attainment.

Educational attainment defined as if a high school diploma or GED was completed by 21 years of age may be subject to measurement error. A similar outcome measure was used for receiving a high school diploma or obtaining a GED.[27] We conducted univariate analysis which showed more than 85% of the sample completed high school or a GED by 21 years of age, which is similar to prior high school and GED completion in the educational literature. Bivariate analysis with confounders and other variables including participant's gender, participant's race/ethnicity, and parental education showed associations that are representative of prior educational attainment literature. This gave credibility to our outcome measure. Overall, the errors from the

exposure and outcome were most likely non-differential misclassifications that affected exposed and unexposed similarly and bias the results toward the null hypothesis (that there was not an association between chronic health conditions and poor educational attainment).

We assessed many potential confounders in our confounder analysis. This reduced the chances of residual confounding. The confounders that were measured may also be subject to misclassification as well. Univariate analyses of all potential confounders were conducted.

2.3 Statistical Approaches to Test Hypotheses

Power Analysis

A power analysis is traditionally implemented before conducting a study when there is primary data collection. Having sufficient power reduces Type II errors, which are when an investigator rejects the alternative hypothesis (true effect) when in fact there is a true effect. An adequate sample size is critical to having sufficient power to detect associations. If the power is too low to detect an association with a fixed set of participants, the researcher may not be able to detect an effect when there is a true effect, and this would be detrimental to a study. Therefore it is important to conduct a power analysis when the sample size is fixed. Also, a power calculation from previous literature may aid in determining the approximate sample size needed to conduct a study.

Our study conducted power analyses based on the associations studied for each paper. For the first manuscript that examined the association between chronic health conditions and educational attainment, the power analysis implemented a two-sample proportional test (two tailed). Power was calculated to examine if there was sufficient

sample size to determine whether an effect can be identified in the association between chronic health conditions and their educational attainment using SAS 9.2. The SAS power procedure, proc power, was implemented to estimate the power from a two-sample proportional test. The proportion (percentage) of youth who reported chronic health conditions and did not attain a high school degree or GED was compared to the proportion of youth who did not have chronic health conditions and did not attain a high school degree or GED.

Results from this analysis found youth with chronic health conditions have a smaller percentage of participants who had completed high school or a GED by 21 years of age. There were 1558 students (22% of the weighted sample) who reported ever having a chronic health condition in 1997 and 2002. Among youth with chronic health conditions, 15% did not receive a high school diploma or GED prior to becoming 21 years of age. Among youth without chronic health conditions, only 12% of youth did not receive a high school diploma or GED prior to becoming 21 years of age (n=5558). Using a likelihood ratio chi-square two-sample proportional test, the power estimate was 0.98 with weighted percentages (two tail). This indicated that there was a 98% chance of detecting a significant difference (alpha=0.05) if there was, in fact, a difference between reported chronic health conditions compared to youth without chronic health conditions and poorer educational attainment. This analysis was an estimate and did not take into account covariates, which may change the difference between proportions.

We wanted to determine whether we would have enough power for our mediation analysis for youth that reported cancer, diabetes or epilepsy compared to youth who did not report a chronic condition. Among youth with cancer, diabetes and epilepsy (n=118),

20% did not receive a high school diploma or a GED by 21 years of age. Among youth who did not report a chronic health condition (n=5638), 12% of them did not receive a high school diploma or a GED by 21 years of age. Using a likelihood ratio chi-square two sample proportional test the power estimate was 0.77 with weighted percentages (two tail) which means that there was a 77% chance of detecting a significant difference (alpha=0.05) if there was, in fact, a difference between youth with cancer, diabetes and epilepsy compared to youth without chronic health conditions and poorer educational attainment.

The second paper examined youth limited by a chronic health condition, early onset of chronic health condition and youth limited and had early onset of a chronic health condition. The variable limited by a chronic health condition was based on whether youth with a chronic health condition reported that their chronic condition currently limited them in 1997 or 2002. For this power analysis, the proportion (percentage) of youth who were limited by their chronic health condition and did not attain a high school degree or GED by 21 years of age was compared to the proportion that did not attain a high school degree or GED by 21 years of age.

There were a total of 559 participants that had a condition that currently limited them “a lot” or “a little.” Among youth currently limited by the chronic health conditions, 17% did not receive a high school diploma or GED prior to becoming 21 years of age. Among youth who did not report a chronic condition, only 12% did not receive a high school diploma or GED prior to becoming 21 years of age. In these proportions, there were 553 participants who were limited by their chronic health conditions and 5731 participants who were not limited by a chronic health condition.

Using a likelihood ratio chi-square two-sample proportional test, the power estimate was 0.97 (two tail) which means that there was a 97% chance of detecting a significant difference (alpha=0.05) if there was in fact a difference in youth reporting being currently limited by their chronic health condition compared to youth who did not report a chronic health condition and poorer educational attainment. This analysis was an estimate and did not take into account covariates, which may change the difference between proportions.

Early onset of a chronic health condition was measured when it was reported how old the participant was when the chronic health condition was first identified, diagnosed or noticed. Youth that reported having a condition at 12 or younger (75% of the earliest conditions) was considered early onset. Among youth with early onset of chronic health conditions, 16% did not receive a high school diploma or GED prior to becoming 21 years of age. Among youth with later onset of chronic conditions, 14% did not receive a high school diploma or GED prior to becoming 21 years of age. Among youth who did not report a chronic condition, 12% did not receive a high school diploma or GED prior to becoming 21 years of age. In these proportions, there were 975 participants who reported early onset of a chronic health condition and 5558 participants who did not report a chronic health condition. Using a likelihood ratio chi-square two-sample proportional test, the power estimate was 0.98 (two tail) which means that there was a 98% chance of detecting a significant difference (alpha=0.05) if there was in fact a difference in youth reporting being currently limited by their chronic health condition compared to youth who did not report a chronic health condition and poorer educational attainment.

Initially, there was also an attempt to detect differences in disease duration and educational attainment using only youth participants that reported onset of a chronic health condition. Based on our power analyses, there would not be enough power to measure disease duration either continuously or categorically (high duration versus low duration) using only the participants that reported onset of chronic health condition. Duration was measured by the age of the participant when the chronic health condition was reported subtracted by the onset of a chronic health condition. The longest duration was used if the participant reported a chronic health condition's duration in both 1997 and 2002.

Our first power analysis used duration as a continuous measure. This required a comparison of group means for youth who did or did not graduate from high school or received a GED by 21 years of age. There were 1,321 participants who reported duration for their chronic health condition in 1997 or 2002 (87% of youth reporting a chronic condition). This power analysis only included these 1,321 subjects. We wanted to determine whether we could examine only the participants that reported a duration. Among youth who graduated from high school or received a GED by 21 years of age, the mean chronic health condition duration was 7.93 years (Standard Deviation (with weights) =281.89, n=1076). Among youth who did not graduate from high school or received a GED by 21 years of age, the mean chronic health duration was 7.56 years (Standard Deviation (with weights) = 297.44, n=245). The estimated power was .05 (two-tailed). This indicated that there was a 5% chance of detecting a significant difference (alpha=0.05) if there was in fact a difference between durations for youth that did or did not complete high school or obtain a GED by 21 years of age. This analysis

did not take into account covariates, which may change the adjusted means. Overall, due to power considerations we cannot adequately compare differences continuously among youth that only reported duration of a chronic health condition. Next, we examined these 1,321 participants categorically as well.

There was also not enough power to measure duration categorically. After looking at a frequency of reported duration, youth who reported duration of 8 years have a cumulative frequency (from 0 years – 8 years) of 53%, the closest cumulative frequency to 50%. For this power analysis, there was division between youth who were considered long duration (8 years or more, n=673) and youth who were considered shorter duration (7 years or less, n=627). The proportion (percentage) of youth who had a long duration of the chronic health condition and did not attain a high school degree or GED by 21 years of age (16.0%) were compared to the proportion of youth who had a shorter duration of the chronic health condition and did not attain a high school degree or GED by 21 years of age (15.5%). Using a likelihood ratio chi-square two-sample proportional test, the power is 0.08 (two-tailed) which means that there was an 8% chance of detecting a significant difference (alpha=0.05) if there was in fact a difference in youth reporting having a long duration compared to only youth with a chronic health condition with a shorter duration and poorer educational attainment. Due to power considerations, we cannot adequately compare differences categorically among only youth that reported onset of a chronic health condition and therefore we cannot measure duration. However, as shown above, we had significant power to examine the association of early onset compared to youth without a chronic health condition and their educational

attainment. Based on these power analyses, we implemented those without a chronic health condition as our comparison group.

The association of youth limited and had early onset of chronic health condition and poor educational attainment was also incorporated in paper 2. Combining onset of a chronic health condition and youth limited by a chronic health condition captured an extremely high-risk group and may better capture the dynamic nature of chronic health conditions. Combining youth limited by a chronic health condition and early onset of a chronic health condition may be an effective estimate for duration. For example, if the participant first identified the chronic health condition when they were 15 and at the time of the interview was not currently limited by the condition, the duration should not be based on the participant's interview age. There were 406 participants that were both limited and had early onset. Youth that did not report a chronic health condition were the comparison group (n=5731).

For this power analysis, the proportion (percentage) of youth who were limited and had early onset and did not attain a high school degree or GED by 21 years of age was compared to the proportion of youth that not did not report a chronic health condition and did not attain a high school degree or GED by 21 years of age. Among youth limited and had early onset, 18% of youth did not receive a high school diploma or GED by 21 years of age or younger. Among youth in the comparison group, only 12% of youth did not receive a high school diploma or GED by 21 years of age. Using a likelihood ratio chi-square two-sample proportional test, the estimated power was 0.975 (two-tailed), which means that there was a 97.5% chance of detecting a significant difference (alpha=0.05) if there was in fact a difference with the early onset and

limitation group compared to youth not reporting a chronic health condition and poorer educational attainment.

In the third paper, we examined moderators within the variable chronic health conditions and educational attainment. The variable whether or not the participant had a chronic health condition was used. Among youth with chronic health conditions, 15% did not receive a high school diploma or GED prior to becoming 21 years of age. Among youth without chronic health conditions, only 12% did not receive a high school diploma or GED prior to becoming 21 years of age (n=5558). Using a likelihood ratio chi-square two-sample proportional test, the power estimate was 0.98 with weighted percentages (two tail) which means that there was a 98% chance of detecting a significant difference (alpha=0.05) if there was, in fact, a difference between reported chronic health conditions compared to youth without chronic health conditions and poorer educational attainment. This analysis was an estimate and did not take into account covariates, which may change the difference between proportions. Based on these analyses we had sufficient power (approximately 80%) to determine associations.

Overall Analysis

Bivariate analysis of the exposure, confounders, academic, psychosocial, neighborhood and school variables were compared with youth who completed high school or GED by 21 years of age based on chi-square and t tests. Wald chi-square tests and percentages were conducted using proc surveyfreq. Means were conducted using proc surveymeans and proc surveyreg was used to obtain t-values. In addition, bivariate analysis of academic and psychosocial variables compared to chronic health conditions were conducted. School and neighborhood-level factors were also compared to chronic

health conditions and the outcome. An alpha level of 0.05 was used throughout the analysis unless otherwise specified.

Multivariate logistic regression was used to estimate the association of chronic health conditions and educational attainment. Proc surveylogistic was used controlling for the complex survey design that included survey weights, clusters and strata. A customized sample weight controls for oversampling and was based on the number of rounds used in the analysis. The primary sampling units (sampling clusters) were used to control for clustering. Strata revealed the participants involved in the two different types of samples used: cross-sectional and oversample.

2.4 Assessment of Potential Mediation and Interaction Effects

Mediation and Effect Modification

Mediation analysis was implemented using Baron and Kenny methodology.[81] A mediator as described in Baron and Kenny methodology must satisfy three conditions: (1) the independent variable is significantly associated with the potential mediator, (2) the potential mediator must be significantly associated with the dependent variable and (3) the dependent variable is significantly associated with the independent variable but when the mediator is added, the association is no longer significant. Multivariate logistic or linear regression was implemented to determine whether the associations met Baron and Kenny conditions. If the mediator was continuous, then proc surveyreg was used.

The categorized chronic health conditions measure and poor educational attainment adjusting for confounders was utilized to evaluate mediators. All academic variables and depressive symptoms were examined as potential mediators. A Sobel test was also conducted on mediators that met Baron and Kenny criteria. Using a test statistic

and p-value, the Sobel test examines whether a hypothesized mediation effect is significantly different compared to not having a mediation effect. The Sobel test examines the pathways from the exposure to the mediator as well as the mediator to the outcome. It additionally requires standard errors of these pathways.

Effect modification was determined by backwards selection with a model that added interaction terms from the school and neighborhood factors and chronic health conditions (See Section 2.5 Model Specification). The core covariates and a 2-parent household were used in the model along with the interaction terms for each covariate with chronic health conditions. If the final model contained interaction terms that had a p-value of 0.05 or less, these variables were stratified. Stratification categories for the effect modification were based on the mean.

2.5 Model Specification

Model Selection

Overall, none of these potential confounders (individual, family, school and neighborhood variables) changed the association of exposures and poor educational attainment by 10%. Each of the variables was associated with poor educational attainment in the bivariate analysis. Therefore we rely on the past literature and past models with U.S. nationally representative samples that examined the association of chronic health conditions and educational attainment. As shown in Section 2.1, we have core variables that were based on the past literature. These variables (gender, race/ethnicity, age and parent education) were included in all analysis. This comprised our core analysis model.

Other potentially confounding variables (see Section 2.1) that were not as frequently used in the literature as the core variables were also examined. We added one additional variable, 2-parent household. This variable represented an important stress measure on the household. We also examined whether any variables contribute to multicollinearity.

Multicollinearity

Along with the variable specification, we also examined whether these variables contributed to multicollinearity. Using the SAS procedure proc reg and our sample weights, we determined the variance inflation factor and tolerance of each of these variables. A variance inflation factor of greater than 10 or a tolerance of 0.10 warrants further investigation. Based on these standards, there were no variables in the models that contributed to multicollinearity. A correlation analysis on each variable was also conducted.

Selection Methods for Neighborhood and School Factors (Paper 1 and Paper 2)

To the best of our knowledge, neighborhood and school factors have never been applied to the association of chronic health conditions and educational attainment. This was why we limited these variables through forward selections in paper 1 and paper 2. A forward or backwards selection are methods to determine whether or not a variable should be kept into the model. A forward selection starts with a core model and untested variables are added to this model until a final model is identified. A backwards selection starts with all the untested variables in the model and removes the variables until a final model is identified.

Each of these methods has drawbacks.[82] A drawback of a backwards selection is that variables that are dropped may be significant when added to the final reduced model.[82] A forward selection as opposed to a backwards selection was employed because we had an existing robust model.[82] This ensured that if variables added to the core model were significant they would be added to the final model. Using a forward selection seemed more prudent compared to starting with all the untested variables and removing these variables with backwards selection.

Forward model selections were conducted with complex survey design using proc surveylogistic based on a SAS macro designed by Wang, F and Shin, HC.[83] This method uses the p-value of the candidate effect with the SAS command slentry. If the p-value of the candidate effect is less than the specified p-value, then this candidate effect enters the model. Our previously selected individual-level variables were kept in these models for forward selection.

There are multiple strategies for trimming variables and some of these are controversial.[84] Initially we examined each forward selection with entering effects having a p-value = 1.0. This allowed us to identify the order that each variable was introduced into the model and provided context for selection criteria. Overall, we concluded that all forward selections would use a significance level of 0.05 for entering effects. We made a determination based on the initial forward models and the literature that this criterion gave a proper representation of the neighborhood and school variables.

For our first paper, we conducted two forward selections for our neighborhood and school variables. The first forward selection was conducted before we had onsite access at the Bureau of Labor Statistics. We did not use this selection in our final

analyses. County-level neighborhood data from the geocoded disc and publicly available school data were used in this forward selection. Our initial model had all individual – level variables that we selected above (gender, race/ethnicity, age, parent education, 2-parent household). Neighborhood and school variables that met entry criteria were included, p-value < 0.05. Through our forward selection, we included type of school. None of the neighborhood county-level met these criteria. However we added county-level neighborhood education as it represented the best fit compared to all other neighborhood variables.

Secondly, forward selections were conducted onsite at the Bureau of Labor Statistics and used census tract-level neighborhood data and school factors. For youth who had a chronic health condition, a forward selection was determined that included neighborhood education, neighborhood income, 5-year teacher turnover, teachers with advanced degrees, type of school, percentage truancy and percentage of students that are Non-Hispanic White.

For our second paper, forward selections were conducted using youth limited by a chronic health condition, early onset of a chronic health condition and youth limited and had early onset of a chronic health conditions. These selections yielded similar results except for the exclusion of census tract-level neighborhood education.

Selection Methods for Paper 3

A backwards selection was conducted that evaluated interactions effects in multiple regression from a series of neighborhood, school and family factors outlined by Jaccard and Turisi.[84] In their book, *Interaction Effects in Multiple Regression*, they specify that a backward elimination strategy can be used for multiple-interaction

effects.[84] A model that includes all of the interaction terms is used and compared to the fit of a model that drops a particular term of interest. Some analysts evaluate one interaction and if this is eliminated then the remaining interaction terms are evaluated without the eliminated term. This is the method we used in our study.

2.6 Assessment of Model Assumptions

Logistic regression model assumptions involve whether the model fits the data and the observations are all independent. Each observation is a particular participant in the study. Based on the goodness of fit chi-square test, these models fit the data well ($p<0.01$). Interaction terms were determined for our models in the third manuscript. The model building techniques that were used included: (1) confounding analysis, (2) multicollinearity analysis and (3) forward and backward selections. These procedures allowed us to create superior, parsimonious models that met model assumptions.

2.7 Limitations

A limitation of this research was that the study was a secondary data analysis. Measures were not developed to answer these hypotheses. The measures are based on self-reported, parent-reported and principal-reported information that are subject to measurement error. In logistic regression analysis the outcome must be discrete. Residual confounding may occur if there is not proper adjustment for unmeasured or unavailable variables. Another limitation is with categorizing chronic health conditions. We tried to classify chronic health conditions based on type reported. Throughout the papers, our analyses are an improvement from past categorization because we include types and onset of chronic health conditions as well as youth limited by chronic health conditions. However, there were still limitations in terms of sample size. There were

several missing values from the school-level. For additional study limitations please refer to Section: 6.2 Strengths and Limitations.

Chapter 3: Manuscript 1

Types of Childhood and Adolescent Chronic Health Conditions and Educational Attainment: A Social Ecological Approach

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Abstract

Background: Youth with chronic health conditions are potentially at risk for poor educational outcomes. This study examined the association between types of chronic health conditions reported during childhood and adolescence and their impact on educational attainment. The youth's school and neighborhood environment and potential mediating factors from academic and psychosocial variables were investigated.

Methods: Using the National Longitudinal Survey of Youth – Cohort 1997, multivariate logistic regression models were fit to estimate the association between types of childhood and adolescent chronic health conditions and educational attainment, adjusting for confounders. Baron and Kenny methodology was used to test for the mediation of academic and psychosocial variables.

Results: Youth who reported ever having a chronic health condition had higher odds of not completing a high school diploma or Graduate Equivalency Degree (GED) by 21 years of age compared to youth who did not report a chronic health condition, OR: 1.47 (95% CI: 1.22 - 1.76). Specifically, youth with asthma, OR: 1.63 (95% CI: 1.31 - 2.02) and youth with cancer, diabetes, or epilepsy, OR: 1.96 (95% CI: 1.13 – 3.37) had higher odds of poor attainment. Academic and psychosocial variables attenuated this association. For students who reported cancer, diabetes, or epilepsy, the variables absences from school, repeated a grade and depressive symptoms score were considered mediators.

Conclusion: Youth with chronic health conditions had lower educational attainment. Students with cancer, diabetes or epilepsy who had a high number of absences, had repeated a grade or had a high depressive symptoms score were particularly impacted.

INTRODUCTION

There are an estimated 32 million children that currently have at least one of twenty chronic health conditions [1]. In the past four decades childhood chronic health conditions have quadrupled [2]. There are similarities with respect to how each unique chronic health condition affects youth [3]. These children constantly live with their condition and may require hospitalizations, home health care, and extensive medical care [3]. They may have a host of medical burdens compounded by everyday life challenges including completing high school or a Graduate Equivalency Degree (GED).

Although previous literature in the U.S. has been mixed with respect to the association of chronic health conditions and educational attainment [4-6], more recent studies have identified a significant association between childhood chronic health conditions and poorer educational attainment [7, 8]. A study in 2011 by Maslow et al using the National Longitudinal Study of Adolescent Health assessed the association between childhood chronic health conditions and educational attainment [7]. Young adults with chronic health conditions were significantly less likely to graduate high school and gain employment compared with healthy young adults. It was concluded that a lack of a consensus definition for youth with chronic health conditions is partially responsible for different results across studies in the previous work [7]. In a review of childhood chronic health condition definitions, van Der Lee et al found discrepancies between studies with respect to type and severity of chronic conditions [9]. Expanding upon this literature, Mokkink, van Der Lee et al developed a consensus definition of childhood chronic health conditions designed for use in large, epidemiological studies [10].

Studies have shown that asthma is unique among chronic health conditions and may need to be separately evaluated. For example, compared to young adults with asthma, those with non-asthmatic chronic health conditions had significantly worse outcomes for high school or GED completion, employment, welfare and received more disability benefits [7]. Young adults with asthma were found to have better educational attainment outcomes compared to those with cancer, diabetes or epilepsy [7].

A study by Haas and Fosse determined that self-reported health was associated with educational attainment and they suggested that this association was mediated by academic and psychosocial variables (i.e. absences, grade point average, feeling safe at school and cognition) after adjusting for demographic variables [11]. Since self-reported health can be physical or psychological, the precise component that contributes significantly to poorer educational attainment remained unknown. Haas and Fosse indicated that academic factors explained most of the association between self-reported health and educational attainment [11]. Their results suggest exploration of contextual factors from the school, neighborhood and family that may influence this association is needed. This rationale supports a social ecological approach.

The purpose of our study was to examine the impact that chronic health conditions or specific types of chronic health conditions may have on a youth's educational attainment. By implementing a social ecological framework, the results of the present study may reveal influential contextual factors involved in the association of chronic health conditions and poor educational attainment from the youth's family, school and neighborhood. The influence of academic and psychosocial factors on this association including potential mediation was also investigated.

METHODS

Study Sample

This study was a secondary analysis that used the National Longitudinal Survey of Youth – Cohort 1997 (NLSY'97), a publicly available dataset [12]. The NLSY'97 is a nationally representative cohort of 8,984 youths aged 12 to 16 as of December 31, 1996 [13]. Non-institutionalized households were selected from 147 primary sampling units and screened for eligible participants. Data were collected in 1997 and participants were followed through 2009 to examine the youths' transition from school to work and adulthood [13]. Baseline parental and youth one-hour interviews were conducted in 1997. These interviews asked about the youth's childhood as well as their health status, academics and schooling. Our dataset included variables through 2009 [12].

Additional information was obtained from the students' high school transcripts and a cognitive examination, which were also publicly available. We acquired on-site access at the Bureau of Labor Statistics that provided the participant's primary sampling unit and census tract residence in 1997. The census tract information was merged with Census 2000 information and student data [14]. A survey of schools the students attended in 1996 and 2000 was linked to student data.

Measures

Exposure – A childhood or adolescent chronic health condition was operationalized from the parent survey or the youth survey. A parent was asked in 1997 if the participant ever had a chronic health condition. The participant was asked in 2002 if they had ever been diagnosed with a chronic health condition. Two distinct periods served to better represent the dynamic nature of chronic health conditions. If the parent or participant

reported that the youth ever had a condition at one of these times, this was recorded as a chronic health condition.

At each interview, the participant or parent was asked to delineate the specific chronic health condition. The parent survey's responses included asthma, heart condition, anemia, diabetes, cancer, epilepsy, and other. "Other" included infectious diseases, Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS), kidney, allergies, other sexually transmitted diseases or other. The 2002 youth survey responses included asthma, cardiovascular or heart condition, anemia, diabetes, cancer, epilepsy, HIV/AIDS, sexually transmitted diseases other than HIV/AIDS and other.

From these responses we categorized chronic health conditions for supplementary analysis using Mokkink et al's consensus definition [10]. The criteria are based on whether the chronic health condition is present for more than three months, will likely last more than three months, or has occurred three times or more during the past year and will most likely reoccur again [10]. Based on these criteria, the chronic health conditions that were not included in our categorized measure were allergies, anemia, infectious diseases and other sexually transmitted diseases.

We classified chronic health conditions into the following four groups: (1) asthma, (2) cancer, diabetes, or epilepsy, (3) heart and cardiovascular conditions and (4) other. These categories were developed based on past literature that showed that non-asthmatic chronic health conditions (defined as cancer, diabetes or epilepsy) are more severe in terms of educational attainment compared to asthma [7]. Cancer, diabetes or epilepsy was also grouped together due to small individual sample sizes. Out of all other

chronic health conditions, heart and cardiovascular conditions had the largest prevalence. Consequently, we were able to have these conditions as a separate category. The rest of the chronic health conditions were combined together into the fourth category, "other."

Six percent of the sample reported more than one chronic health condition. Multiple conditions were categorized according to the disease that the previous literature reported having the highest impact on educational attainment.

Outcome – Educational attainment was defined as completion of a high school degree or GED by 21 years of age. Participants were asked at each survey period when or if they had completed high school. The NLSY'97 staff created measures that incorporated the month and year each student had completed a high school degree or a GED. These measures were used in our study.

Covariates – Variables from the neighborhood, school, family and individual were selected based on past literature and theory from prior models of chronic health conditions and educational attainment. Individual level control variables were collected from the parental and youth surveys. Academic and psychosocial variables were chosen from the previous literature. Individual level academic variables were collected from transcripts, the youth surveys and a cognitive test. Individual level psychosocial variables were also collected from the youth surveys. School level variables were collected from the school surveys accessed on-site at the Bureau of Labor Statistics. Neighborhood level variables were collected from the census tracts in which each participant resided in 1997.

Individual Level: Control Variables

The following control variables were considered core variables and used in all analyses: (1) participant's age, (2) participant's gender, (3) participant's race/ethnicity, (4) parent education level. These variables have been used frequently in the past literature on the U.S. population and were all collected at baseline in 1997 [7, 11]. We also included whether or not the participant in 1997 had a 2-parent household. The number of parents in a family is an important variable because it represents a stressor from the household.

Participant's race/ethnicity was categorized as: (1) Black, Non-Hispanic, (2) Hispanic (3) Mixed Race, Non-Hispanic, (4) Non-Black, Non-Hispanic. This variable was categorized by survey staff and incorporated the 1997 race and ethnicity questions, parent's background, and household oversampling information. Mixed Race- Non-Hispanic was only 1% of the sample. Consequently, this category was combined with Black, Non-Hispanic. The Non-Hispanic and Non-Black category was 94% White but also included every other racial and ethnic group reported. Parent education level was assessed by the highest grade that the mother or father completed. This was based on a 0 (no previous education) to 20 (8 years of college or more) scale.

Individual Level: Academic Variables

The Computer Adapted Test - Armed Services Vocational Aptitude Battery (CAT-ASVAB) was used to assess a participant's cognitive score. This examination was administered to participants in 1997 or 1998 and contains four sections: (1) mathematical knowledge, (2) arithmetic reasoning, (3) word knowledge and (4) paragraph comprehension. Sampling weights based on age were applied and aggregate verbal and math scores were computed. Percentile scores were assigned ranging from 0-99. An

exhaustive review of the validity of the CAT-ASVAB was conducted [15]. Factor analyses were performed using the NLSY'97 and each section showed good content validity [15]. The CAT-ASVAB has an overall estimated reliability of 0.97 [16].

Grade point average (GPA) was calculated from student's high school transcripts. This information was collected in two stages. Transcripts were first obtained in 2000 for students born in 1980 and 1981. Another collection cycle was performed in 2004 for all students including those that were missing transcript information from the first data collection. A participant's grades were weighted by the quality of credits received by the Carnegie weighting system [12]. Scores ranged from 0.0 to 5.0.

Absences from school were identified by the maximum number of days reported absent in either transcripts or the youth survey. The number of absences during the 1997 fall term was self-reported by participants and the number of absences for the 1999, 2000 and 2001 school years were determined from transcripts. If transcript information was missing in these years, self-reported absences were used.

The number of grades that the participant ever repeated in elementary school, middle school and high school was used to assess participants that had repeated a grade. A cumulative measure was constructed by survey staff that incorporated the 1997 parent survey and follow up youth surveys. This variable was categorized into "2 or more repeated grades", "1 repeated grade" and "Never repeated a grade." For the mediation analysis, this variable was collapsed into "Ever repeated a grade" or "Never repeated a grade."

Individual Level: Psychosocial Variables

Whether the participant felt safe in school was operationalized by a question in the 1997 youth survey, with responses on a 4-point Likert scale ranging from "strongly agree" to "strongly disagree" [12].

The number of depressive symptoms score was assessed by the Mental Health Inventory-5 (MHI-5) [17, 18], and was transformed to a score of 0-100 by a linear transformation. The inventory was assessed biennially from 2000 through 2008. The score from 2000 was used unless a response was missing, in which case the 2002 response was added (n=398, 4%). A higher score was representative of more depressive symptoms. The Cronbach alpha for the MHI-5 is 0.82 and has been examined and validated in many large populations [19, 20]. The MHI-5 is a short screening questionnaire that cannot be used to generate a formal psychiatric diagnosis [18]. Cut-offs for depression have been studied but there has not been a widely accepted cutpoint [21, 22, 23].

Substance abuse was determined by three questions asked in 1997: if the participant ever smoked, ever drank alcohol or ever used marijuana. The categories created were (1) if the participant reported using all three, (2) reported using any of them but not all three, or (3) reported using none.

Finally, a participant being a victim of bullying was operationalized by two questions: (1) whether the participant reported being a victim of repeated bullying before age 12, (2) whether the participant reported being a victim of repeated bullying from 12 – 18 years of age. The questions were asked in 1997 and 1999, respectively. If the

participant responded yes to either question they were categorized as being a victim of bullying.

Community Level: Neighborhood

Neighborhood education was determined from Census 2000 and operationalized by the percentage of people with less than a high school degree from the census tract. Neighborhood Income was assessed by the median household income in 1999 from the census tract. Variables were tested continuously.

Community Level: School

In 1996, the National Opinion Research Center (NORC) prepared surveys to send to all schools with a 12^{th} grade within each primary sampling unit. A commercial database was used to determine eligible schools. New schools that participants attended after the baseline year as well as the original schools were surveyed in 2000. These school assessments were known as the School Surveys. If a variable was missing in 1996, the 2000 survey was used.

From the School Surveys, the following variables were used: (1) school type, (2) percentage of Non-Hispanic Whites, (3) percentage of teachers with advanced degrees, (4) 5-year teacher turnover, (5) percentage truancy and (5) school type.

School type was categorized as (1) public and (2) private. This variable offered many types of schools but was collapsed into these two groups due to limited sample size. Percentage of Non-Hispanic Whites and percentage of teachers with advanced degrees were analyzed categorically. The distribution of these variables was examined and the sample mean was used to ensure similar sample size for higher and lower categories. In examining racial achievement differences, Nettles et al determined that

having a higher or lower categorical percentage of white students in the school affected the achievement of all students in the school [24]. The percentage of students with advanced degrees was initially analyzed continuously. From examining the data, slight percentage differences did not properly display the effect on educational attainment.

Analysis

Descriptive statistics on types of chronic health conditions and covariates were performed. Each of these variables was compared to high school completion by bivariate analysis using either a chi-square test or a t-test. Multivariate logistic regression was used to test the association between chronic health conditions and not completing high school or a GED by age 21, controlling for sociodemographic variables and examining the influences of academic and psychosocial variables, as well the youth's neighborhood and school. Multiple models were fit with various categories for chronic health conditions implementing SAS 9.2 (SAS Institute, Cary, NC). Proc surveylogistic was used to estimate odds ratios. Only complete cases were used. The analytic sample for our final model was n=6,795 (Figure 1). The school variables had many missing values (n=3760). A missing data analysis revealed that missing values from the school and neighborhood were similar to the analytic sample based on the exposure and confounders. However it was determined that the analytic sample had a significantly higher parent's education level (by half a grade), was comprised of an older population (by 14 months) and had a higher percentage of Non-Hispanic, Non-Blacks (by 3.6 percent). A model comparison revealed that the odd ratios for our main association were very similar for missing school values versus the analytic sample.

Baron and Kenny methodology was used to determine whether each academic and psychosocial variable was considered a full mediator [25]. There were three main criteria that needed to be satisfied (Figure 2). Path a required that the independent variable was significantly associated with the mediator. Path b required that the mediator was significantly associated with the dependent variable. Path c required that the independent variable was significantly associated with the dependent variable but when the mediator was introduced the association was no longer significant. For mediators that were represented continuously, the SAS procedure, proc surveyreg was used to estimate Path a. If a mediator satisfied Baron and Kenny's criteria, a Sobel test was conducted. All models controlled for the complex survey design of the NLSY '97 using customized survey weights, primary sampling units and strata.

Model Selection

Variables were defined from the previous literature using nationally representative US samples. Each confounding variable did not contribute to multicollinearity. Gender, race/ethnicity, age of the participant from the individual level, as well as whether the family included both parents were confounders controlled for in the analysis. This group of variables along with our exposure created our final model.

Factors Added to Final Model

Academic, psychosocial, school, and neighborhood variables were added separately to the final model. To the best of our knowledge, neighborhood and school variables have never been studied in the association of chronic health conditions and poor educational attainment but fit with our social ecologic approach. Neighborhood and school variables were restricted through a forward selection using a SAS macro [26]. Since we had a

robust core model, this method was deemed more judicious then a backwards selection that may drop significant variables added to the robust model.

RESULTS

Table 1 provides sociodemographic characteristics of the whole sample, frequencies of each chronic health condition and bivariate analyses across educational status. Overall, 22% reported having had a chronic health condition. The sample consisted of 51% male, 26% Black and 21% Hispanic. Among youth reporting whether or not they had a chronic health condition, 15% did not complete high school or a GED by 21 years of age compared with 12% with no chronic health conditions. Among youth with asthma, 17% did not complete high school or a GED by 21 years of age (comprises 19% of sample) and among youth with cancer, diabetes, or epilepsy, 20% did not complete a high school or GED (comprises 3% of sample). For youth with heart or cardiovascular conditions, 10% did not complete high school (comprises 1% of sample).

In Table 2, the results of 5 models are provided. The odds of not completing a high school diploma or a GED by 21 years of age were higher for youth who reported a chronic health condition, OR: 1.50 (95% CI: 1.26 - 1.79) compared to youth who did not report a chronic health condition adjusting for core variables (Model 2.1). Adjusting for number of parents in the household resulted in similar odds, OR: 1.47 (95% CI: 1.22 - 1.75) (Model 2.2).

After adjusting for individual level academic variables, the association was no longer significant, OR: 1.21 (95% CI: 0.85 - 1.71) (Model 2.3). Substituting individual level psychosocial variables for the academic variables into the model, the association with chronic health conditions and educational attainment was also no longer significant,

OR: 1.17 (95% CI: 0.95 - 1.43) (Model 2.4). In general (Tables 2 – 4) the variables, repeated a grade, absences from school, GPA, cognitive score and depressive symptoms, adjusting for confounders, were each significant contributors of poor educational attainment.

As displayed in Tables 3 and 4, we fit models from our categorized chronic health condition variable with each academic variable (Table 3), and psychosocial variable (Table 4) separately. The odds of not completing a high school diploma or a GED by 21 years of age were higher for youth who had asthma, OR: 1.63 (95% CI: 1.31 - 2.02) and youth who had cancer, diabetes or epilepsy, 1.96 (95% CI: 1.13 - 3.37) compared to youth who never reported a chronic health condition, adjusting for confounders (Model 3.1). Youth who had heart or cardiovascular conditions had educational attainment that was no different from youth who never reported chronic health conditions, OR: 0.80 (95% CI: 0.38- 1.68) (Model 3.1).

Among participants reporting having cancer, diabetes or epilepsy, the association with poorer educational attainment was no longer significant when any of the academic variables were added to the model (Model 3.2 – 3.5). In contrast, among youth with asthma, the association between poorer educational attainment remained significant when the academic variables were included in the models (Model 3.2 – 3.5).

As shown in Table 4, among youth with cancer, diabetes or epilepsy, depressive symptoms reduced the point estimates such that previous associations with poor educational attainment were no longer significant. Among youth with asthma the point estimates were reduced but the previous associations with poor educational attainment were still significant. The psychosocial variables of substance use, victim of bullying and

felt safe at school did not have a large effect on types of chronic health conditions and educational attainment and were not studied in the mediation analysis.

The models shown in Table 5 present the results of chronic health conditions and educational attainment associations using neighborhood and school-level variables. The neighborhood and school variables did not change the association of chronic health conditions and educational attainment (Models 5.2- 5.5). Model 5.3 introduced school-level variables only from the first group of schools surveyed (1997), n=2589. Model 5.4 incorporated additional schools that were surveyed in either 1996 or 2000 because of the missing information from the student's school attended in 1997, n=3453. Model 5.3 and Model 5.4 yield similar results, OR: 1.49 (95% CI: 1.09 – 2.04) (Model 5.3), OR: 1.47 (95% CI: 1.23 – 1.77) (Model 5.4). The last model showed that the odds of not completing high school for youth with a chronic health condition were still significantly higher compared to youth without a chronic health condition when adjusting for all neighborhood and school factors, OR: 1.47 (95% CI: 1.12 – 1.91).

Mediation Analysis

All academic variables as well as depressive symptoms significantly attenuated the association of cancer, diabetes or epilepsy and poor educational attainment. Thus, these factors were examined as potential mediators. Among academic variables studied, repeated a grade (Figure 3A) and absences from school (Figure 3B) both satisfied Baron and Kenny methodology and acted as full mediators in the association of cancer, diabetes or epilepsy and poor educational attainment. The Sobel test was then conducted for repeated a grade (p-value = 0.02) and absences from school (p-value = 0.06). This test estimates whether a mediation effect is significant. Participant's cognitive score and

GPA each did not meet Baron and Kenny Methodology as a full mediator. Depressive symptoms score satisfied Baron and Kenny criteria as a full mediator (Figure 3C). The Sobel test was then conducted for depressive symptoms score (p-value <0.01).

DISCUSSION

Overall, youth who reported having a chronic health condition had significantly higher odds of not completing high school or obtaining a GED by 21 years of age compared to youth who did not report a chronic health condition. Specifically, this association held for asthma, and cancer, diabetes or epilepsy, but not for heart or cardiovascular conditions. These findings are consistent with prior literature from Maslow et al using data from the National Longitudinal Survey of Adolescent Health [7]. Their study included young adults aged 18 to 28 years who reflected on their childhood with chronic health conditions and assessed educational attainment in terms of high school graduation. Our study used an adolescent population in which parents and the participant reported on more recent chronic health conditions. Thus, the measures from the present study were more proximal and potentially more precise.

Our results should be examined within a poverty context. This study adjusts for socioeconomic status at baseline (1997). Youth who experience poverty in childhood are more likely to have poor educational attainment and may be more likely to have a chronic health condition. Our study established an association independent of current socioeconomic status between chronic health conditions and poor educational attainment. However the cumulative effects of poverty before the youth enters the study should not be discounted.

When including academic and psychosocial covariates, the association between chronic health conditions and poorer educational attainment was no longer significant. This is similar to the results of Haas and Fosse, who reported the association of self-reported health and educational attainment was attenuated by academic and psychosocial factors [11].

For youth with cancer, diabetes or epilepsy, the inclusion of academic factors significantly reduced the association with poor educational attainment. Past research has found that certain chronic health conditions in childhood and adolescence may result in lower achievement scores [27, 28].

The association with youth who reported asthma and poor educational attainment was not largely affected by the academic variables except the variable, grade point average (GPA). It is reasonable that asthma is less likely to affect cognition compared to cancer, diabetes or epilepsy. However, it was unexpected that the asthma and poor educational attainment association was not affected by school absences.

Past research has shown that asthma affects school absences [29, 30]. These studies assessed students who currently had asthma. An association between asthma severity and a higher number of school absences was previously found [29]. In our study, youth who reported asthma had a significantly higher number of school absences compared to youth without a chronic health condition (8.54 days versus 7.26 days). Our asthma measure was comprised of youth that reported ever having asthma and consequently our findings may be a reflection of the different measure used.

After mediation analysis on academic variables was conducted, repeated a grade and absences from school satisfied criteria as mediators. GPA and cognitive score did

not. Our results suggest that ability (cognitive score) and achievement (GPA) are not acting alone to lead to poor educational attainment for youth with cancer, diabetes or epilepsy. However these results suggest that academic changes in school attendance and grade retention that occurred for youth with cancer, diabetes or epilepsy ultimately lead to poor high school completion.

There is an important correlation between school absences and grade repetition. Past literature shows that school absences can lead to grade repetition [31]. Grade repetition has a strong relationship with dropping out of school and other poor long term outcomes [32]. This suggests that a potential mechanism to poor educational attainment is that students with cancer, diabetes, or epilepsy likely have frequent and/or prolonged absences, which reduces the opportunity to learn and thereby lowers achievement. These factors can affect grade retention. Grade retention makes it more likely for these students to drop out of high school. Overall, these study results indicate that students with cancer, diabetes or epilepsy could benefit from additional academic support and a potential plan to avoid repeating grades from having a high amount of absences.

The only major psychosocial variable that attenuated the observed associations for youth with cancer, diabetes or epilepsy was depressive symptoms score. This was also the case for youth with asthma; however, the association between youth with asthma and poor educational attainment still remained significant. These results are consistent with the extant literature on depression and educational outcomes [33, 34]. Specifically, one study found that depressive symptoms decrease years of schooling completed, and increase the probability of dropping out of high school [33]. This phenomenon may be magnified in youth with chronic health conditions.

It has been suggested that health care providers may overlook depression in patients with a chronic health condition because the focus of medical interactions is on the management of the condition. Depressive symptoms, such as fatigue, may be interpreted as part of the chronic health condition [35]. Our results show that depressive symptoms among adolescents with chronic health conditions, particularly asthma, cancer, diabetes and epilepsy, need to be a clinical priority to optimize their educational outcomes.

Depressive symptoms score were also considered a mediator specific to cancer, diabetes or epilepsy. This suggests that suffering from one of these chronic health conditions and depressive symptoms score is along the causal pathway to poor educational attainment. Clay believed that depression is a result of poor coping with the chronic condition's effects [36]. Absenteeism or grade repetition may lead to a higher depressive symptoms score and then affect poor educational attainment. Depending on the severity or type of condition, it may be very hard to have the student attend school on a regular basis even with a corrective academic plan and support. This makes coping strategies critical to reducing poor educational attainment.

Neither school nor neighborhood variables influenced the association between chronic health conditions and education attainment. Because academic variables attenuated the association between chronic health conditions and educational attainment, we thought school variables might also be important. However, these associations need to be further studied. The participant's neighborhood defined at the census tract level may not properly represent the participant's actual neighborhood. The census block group or a participant's own interpretation of the neighborhood's parameters may better

represent the neighborhood. Additionally, participants may have moved from the first survey year in 1997. School survey variables had missing values, which may have affected our results. Perhaps the school level and neighborhood level variables are better suited as effect modifiers as opposed to confounders. There may be interactions based on different levels of the school and neighborhood with chronic health conditions in which stratification may better represent these associations.

Strengths of this study are the cohort design, which inherently involves temporality since the exposure was measured before the outcome. The National Longitudinal Survey of Youth was an important dataset to use because it follows youth through adolescence into adulthood as they are achieving their educational outcomes. Not only were we able to isolate different types of chronic health conditions, we were also able to examine a critical trajectory in a person's educational attainment. Having objective measures such as transcript information, a cognitive examination and a depression inventory also allowed better examination of key pathways in this association. This study also incorporated a multi-level approach. Contextual factors are important for a participant's educational attainment and influences from the neighborhood and school had never been studied for this association.

Limitations of this study included that it was a secondary analysis. The 1997 parent survey asks whether the participant ever had a chronic health condition and the 2002 youth survey asks whether the participant was ever diagnosed with a chronic health condition. A self-reported diagnosis is an important limitation because those parents who are more involved and knowledgeable in health issues may be more cognizant of the participant's health. These parents would be more likely to report a chronic health

condition. A diagnosis by a physician requires the participant to see a doctor. Health access may be restricted for impoverished participants. These limitations in the surveys affect the participants with chronic health conditions that we capture in the study. Also, many participants reported other chronic health conditions that were not asked about in either survey. We cannot be sure whether we captured all the participants with these other chronic health conditions.

There were limitations in terms of sample size for individual chronic diseases. With cohort studies, there is participant attrition that affects sample size. This study had less than 17% attrition by 2009 (Round 13). Mental health chronic conditions were not examined in this study.

Timing of onset of chronic health conditions and youth limited by their chronic health conditions in childhood and adolescence and educational attainment needs to be further understood. Also, the overall mental health of a participant may be further elucidated. Whether or not a clinical diagnosis of depression, instead of only elevated depressive symptoms score, leads to poorer educational attainment also needs to be better identified.

In conclusion, an association between chronic health conditions and poor educational attainment was determined. This study also identified academic and psychosocial factors including potential mechanisms for youth with specific chronic health conditions. These findings may aid in developing preventative strategies to keep these youth in school or to keep these students on a successful educational trajectory.

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Table 1: Weighted Sample Characteristics Of The National Longitudinal Survey of Youth - Cohort, 1997 By Completion Of A High School Degree Or Graduate Equivalency Degree

	Overall n=8984 %[1] Or Mean (SE[2])	Completed A HSD[3] Or GED[4] By 21 Years Of Age, (%) n=7286	Did Not Attain A HSD Or GED By 21 Years Of Age, (%) n=1563	p-value
Variable, Sample Size	100%	84.55%	15.45%	
Exposure				
Chronic Health Condition (%) n=7196				
Did Not Ever Have A Chronic Health Condition	77.83%	78.65%	72.46%	χ^2: p<0.01
Ever Had A Chronic Health Condition	22.17%	21.35%	27.54%	
Asthma n=986	14.10%	13.45%	18.85%	χ^2: p<0.01
Cancer, Diabetes, or Epilepsy n=121	1.86%	1.67%	3.00%	χ^2: p<0.01
Cancer	0.70%	0.66%	0.94%	
Diabetes	0.70%	0.62%	1.23%	
Epilepsy	0.46%	0.39%	0.83%	
Heart And Cardiovascular Conditions n=105	1.52%	1.53%	1.24%	χ^2: p=0.70
Other (HIV[5], Kidney, Other) n=171	2.58%	2.55%	2.64%	χ^2: p=0.62
Allergies/Anemia/Infectious Disease/STDs[6]*	2.11%	2.15%	1.81%	*
Individual – Student Background				
Age- January 1, 1997 (n=8984)	14.54 (0.02)	14.55 (0.02)	14.54 (0.04)	t: p=0.86
Race/Ethnicity (%) n=8984				
Black, Non-Hispanic	15.40%	14.16%	21.31%	χ^2: p<0.01
Hispanic	12.86%	11.80%	18.26%	
Mixed Race, Non-Hispanic	1.23%	1.25%	0.88%	
Non-Black, Non-Hispanic	70.50%	72.78%	59.55%	
Gender (%) n=8984				
Male	51.32%	50.36%	55.74%	χ^2: p<0.01
Female	48.68%	49.64%	44.26%	

Individual – Family				
Parent's Education Level (Highest Grade) n=8503	13.58 (0.09)	13.88 (0.09)	12.00 (0.10)	t: p<0.01
2-Parent Household (%) n=8984				
No	47.06%	43.35%	65.45%	χ^2: p<0.01
Yes	52.94%	56.65%	34.55%	
Individual – Psychosocial				
Depressive Symptoms (n=8417)	31.24 (0.23)	30.69 (0.22)	34.34 (0.67)	t: p<0.01
Substance Abuse (%) n=8950				
Ever Used Alcohol, Smoked And Used Marijuana	17.74%	16.26%	24.63%	χ^2: p<0.01
Ever Used Alcohol Or Smoked Or Used Marijuana	37.94%	38.04%	37.77%	
Did Not Use Any Of The Above	44.32%	45.69%	37.61%	
Victim of Bullying (%) n=8844				
No	78.88%	79.58%	75.23%	χ^2: p<0.01
Yes	21.12%	20.42%	24.78%	
Felt Safe At School (%) n=8959				
Strongly Agree	34.24%	36.36%	23.69%	
Agree	53.12%	52.95%	53.66%	χ^2: p<0.01
Disagree	9.94%	8.46%	17.67%	
Strongly Disagree	2.70%	2.23%	4.98%	
Individual – Academic				
Absences from School (days) (n=8727)	7.45 (0.23)	6.92 (0.24)	10.25 (0.47)	t: p<0.01
Ever Repeated A Grade (%) n=5943				
Never Repeated A Grade	82.40%	86.87%	52.02%	χ^2: p<0.01
Repeated A Grade	17.60%	13.13%	47.98%	
2 Or More Repeated Grades	2.96%	1.73%	36.68%	χ^2: p<0.01
1 Repeated Grade	14.64%	11.41%	11.30%	
Grade Point Average (n= 6155)	2.82 (0.02)	2.90 (0.02)	2.14 (0.04)	t: p<0.01
Cognitive Score (percentile) (n=7093)	50.41 (0.73)	54.45 (0.66)	25.25 (0.94)	t: p<0.01
Community – Neighborhood				

Neighborhood Income (n=8959)	$44,894 ($1,287)	$46,022 ($1,386)	$39,178 ($845)	t: $p<0.01$
Neighborhood Education (n=8961)	20.71% (0.67)	19.77% (0.66)	25.60% (0.85)	t: $p<0.01$
Community – School				
Type of School (%) n=5223				
Public School	91.69%	90.90%	96.58%	χ^2: $p<0.01$
Private School	8.31%	9.10%	3.42%	
Percentage of Non-Hispanic White (%) n=5224				
Greater Than Or Equal To Mean	62.46%	64.33%	50.32%	χ^2: $p<0.01$
Less Than Mean	37.54%	35.68%	49.68%	
Percentage of Teachers with Advanced Degrees (%) n=5083				
Greater Than Or Equal To Mean	52.89%	52.62%	54.07%	χ^2: $p=0.55$
Less Than Mean	47.11%	47.38%	45.93%	
5 Year Teacher Turnover (n= 5106)	83.10% (0.59)	83.35% (0.60)	81.25% (0.91)	t: $p=0.01$
Percentage Truancy (n=4847)	3.96% (0.30)	3.78% (0.33)	4.98% (0.33)	t: $p<0.01$

*Not included in the categorized chronic health variable

[1] %: Percentage [2] SE: Standard Error [3] HSD: High School Diploma [4] GED: Graduate Equivalency Degree [5] HIV: Human Immunodeficiency Virus [6] STDs: Sexually Transmitted Diseases

Table 2: Logistic Regression Of Chronic Health Conditions And Poor Educational Attainment (Did Not Complete High School Or Graduate Equivalency Degree By 21 Years Of Age)

Individual	OR[1] (95% CI)[2] N = Observations	Model 1, n=6795	Model 2, n=6795	Model 3, n= 4109	Model 4, n=6617
Chronic Health Conditions	Ever Had A Chronic Health Condition	**1.50 (1.26 - 1.79)**	**1.47 (1.22 - 1.76)**	1.21 (0.85 - 1.71)	1.17 (0.96 - 1.44)
	Did Not Ever Have A Chronic Health Condition	(ref)	(ref)	(ref)	(ref)
Race/Ethnicity	Black or Mixed Race, Non-Hispanic	1.56 (1.24 - 1.96)	1.21 (0.94 - 1.56)	0.51 (0.36 - 0.72)	1.34 (1.03 - 1.76)
	Hispanic	0.90 (0.68 - 1.18)	0.98 (0.75 - 1.28)	0.95 (0.63 - 1.43)	1.05 (0.81 - 1.37)
	Non-Black, Non-Hispanic	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.77 (0.66 - 0.89)	0.73 (0.62 - 0.86)	0.94 (0.70 - 1.25)	0.70 (0.59 - 0.84)
	Male	(ref)	(ref)	(ref)	(ref)
Age		1.00 (1.00 - 1.00)	1.00 (1.00 - 1.01)	1.00 (0.99 - 1.01)	1.01 (1.00 - 1.01)
Family	Parent Education Level	0.74 (0.72 - 0.77)	0.76 (0.74 - 0.79)	0.88 (0.82 - 0.94)	0.75 (0.72 - 0.78)
2-Parent Household	Yes		0.39 (0.32 - 0.46)	0.43 (0.31 - 0.59)	0.40 (0.33 - 0.49)
	No		(ref)	(ref)	(ref)
Academic	Grade Point Average			0.39 (0.31 - 0.48)	
Absences from School	Absences (Days)			1.01 (1.00 - 1.02)	
Cognitive Score	CAT- ASVAB[3] (percentile)			0.97 (0.96 - 0.97)	
P**sychosocial** – Substance Abuse	Alcohol, Smoking and Marijuana				2.55 (2.03 – 3.22)
	Alcohol, Smoking or Marijuana				1.49 (1.23- 1.80)
	Used None				(ref)
Depressive Symptoms	Mental Health Inventory				1.01 (1.01 - 1.02)
Victim of Bullying	Yes				1.08 (0.89 - 1.31)
	No				(ref)
Felt Safe at School	Strongly Agree				(ref)
	Agree				1.41 (1.12 - 1.78)
	Disagree				2.42 (1.81 – 3.24)
	Strongly Disagree				2.22 (1.44 - 3.41)

Model 1: Adjusted for Demographic Factors, Model 2: Final Model Adjusted for Confounders, Model 3: Adjusted for Academic Factors, Model 4: Adjusted for Psychosocial Factors

[1] OR: Odds Ratio [2] CI: Confidence Interval [3] CAT-ASVAB: Computer Adapted Test: Armed Services Vocational Aptitude Battery, (ref): Reference Group

Table 3: Logistic Regression Of Poor Educational Attainment With Categorized Chronic Health Conditions And Academic Variables

	Model	Model 1	Model 2	Model 3	Model 4	Model 5
	OR[1] (95% CI)[2] n= Observations	n= 6795	n= 5115	N = 5662	N = 6634	n= 4913
Chronic Health Conditions	Asthma	**1.63 (1.31 - 2.02)**	**1.74 (1.30 - 2.31)**	**1.71 (1.31 - 2.23)**	**1.66 (1.33 - 2.07)**	**1.46 (1.05 - 2.03)**
	Cancer, Diabetes, Epilepsy	**1.96 (1.13 - 3.37)**	1.52 (0.69 - 3.35)	1.52 (0.78 - 2.95)	1.82 (0.99 - 3.35)	1.89 (0.91 - 3.96)
	Heart Conditions	0.80 (0.38 - 1.68)	1.16 (0.45 - 3.03)	1.34 (0.55 - 3.23)	0.74 (0.35 - 1.57)	0.65 (0.20 - 2.11)
	Other	1.27 (0.74 - 2.18)	1.41 (0.68 - 2.90)	1.19 (0.62 - 2.28)	1.24 (0.71 - 2.18)	0.74 (0.29 - 1.89)
	Never Reporting	(ref)	(ref)	(ref)	(ref)	(ref)
Race/ Ethnicity	Black or Mixed Race, Non-Hispanic	1.24 (.97 - 2.18)	0.82 (0.64 - 1.05)	0.54 (0.41 - 0.70)	1.26 (0.98 - 1.62)	0.99 (0.71 - 1.37)
	Hispanic	0.99 (0.76 - 1.29)	0.92 (0.69 - 1.22)	0.77 (0.56 - 1.07)	0.99 (0.75 - 1.30)	1.27 (0.90 - 1.79)
	Non-Black, Non-Hispanic	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.75 (0.64 - 0.87)	0.84 (0.66 - 1.07)	0.85 (0.70 - 1.02)	0.71 (0.60 - 0.83)	0.88 (0.70 - 1.09)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (1.00 - 1.00)	1.01 (1.00 - 1.01)	1.00 (1.00 - 1.01)	1.00 (1.00 - 1.00)	1.00 (0.99 - 1.01)
Parent Education Level		0.76 (0.73 - 0.78)	0.76 (0.73 - 0.80)	0.85 (0.81 - 0.88)	0.76 (0.73 - 0.79)	0.82 (0.78 - 0.86)
2-Parent Household	Yes	0.38 (0.32 - 0.45)	0.50 (0.39 - 0.63)	0.39 (0.31 - 0.49)	0.40 (0.33 - 0.48)	0.44 (0.34 - 0.58)
	No	(ref)	(ref)	(ref)	(ref)	(ref)
Repeated a Grade	1		5.75 (4.45 - 7.42)			
	2 or more		11.14 (7.67 - 16.18)			
	None		(ref)			
Grade Point Average						0.34 (0.27 - 0.42)
Absences from School					1.01(1.01 - 1.02)	
Cognitive Score	CAT - ASVAB[3] (percentile)			0.96 (0.95 - 0.96)		

Model 1: Final Model Adjusting for Confounders, Model 2: Adjusted for Grade Repetition, Model 3: Adjusted for Cognitive Score, Model 4: Adjusted for Absences, Model 5 Adjusted for Grade Point Average

[1] OR: Odds Ratio [2] CI: Confidence Interval [3] CAT- ASVAB: Computer Adapted Test - Armed Services Vocational Aptitude Battery, (ref): Reference Group

Table 4: Logistic Regression Of Poor Educational Attainment With Categorized Chronic Health And Psychosocial Variables

	Model	Model 1	Model 2	Model 3	Model 4	Model 5
	OR[1] 95% CI[2] N = Observations	n= 6795	n= 6774	n= 6742	n= 6691	n= 6783
Chronic Health Conditions	Asthma	**1.63 (1.31 - 2.02)**	**1.61 (1.29 - 2.01)**	**1.38 (1.10 - 1.74)**	**1.56 (1.25 - 1.97)**	**1.60 (1.29 - 2.00)**
	Cancer, Diabetes, Epilepsy	**1.96 (1.13 - 3.37)**	**1.83 (1.07 - 3.15)**	1.49 (0.83- 2.66)	**2.00 (1.15 - 3.47)**	**1.75 (1.00 - 3.08)**
	Heart Conditions	0.80 (0.38 - 1.68)	0.81 (0.39 - 1.72)	0.69 (0.31 - 1.51)	0.80 (0.38 - 1.70)	0.79 (0.37 - 1.70)
	Other	1.27 (0.74 - 2.18)	1.14 (0.65 - 1.98)	1.00 (0.56 - 1.79)	1.32 (0.77 - 2.27)	1.30 (0.76 - 2.23)
	Never Reporting	(ref)	(ref)	(ref)	(ref)	(ref)
Race/Ethnicity	Black or Mixed Race, Non-Hispanic	1.24 (0.97 - 2.18)	1.43 (1.11 - 1.84)	1.28 (0.99 - 1.64)	1.24 (0.97 - 1.60)	1.12 (0.88 - 1.44)
	Hispanic	0.99 (0.76 - 1.29)	1.05 (0.81 - 1.37)	1.01 (0.77 - 1.32)	1.01 (0.78 - 1.32)	0.96 (0.74 - 1.25)
	Non-Black, Non-Hispanic	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.75 (0.64 - 0.87)	0.76 (0.64 - 0.88)	0.67 (0.57 - 0.79)	0.78 (0.66 - 0.92)	0.76 (0.74 - 0.79)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (1.00 - 1.00)	1.01 (1.00 - 1.01)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
Parent's Education Level		0.76 (0.73 - 0.78)	0.75 (0.73 - 0.78)	0.75 (0.72 - 0.78)	0.75 (0.73 - 0.78)	0.76 (0.74 - 0.79)
2-Parent Household	Yes	0.38 (0.32 - 0.45)	0.41 (0.34 - 0.49)	0.36 (0.30 - 0.44)	0.38 (0.32 - 0.46)	0.39 (0.33 - 0.47)
	No		(ref)	(ref)	(ref)	(ref)
Psychosocial						
Substance Abuse	Alcohol, Smoking and Marijuana		2.48 (1.98 - 3.11)			
	Alcohol, Smoking or Marijuana		1.44 (1.20 - 1. 72)			
	Used None		(ref)			
Depressive Symptoms	Mental Health Inventory			1.01 (1.01 - 1.02)		
Victim of Bullying	Yes				1.26 (1.06 - 1.50)	
	No				(ref)	
Felt Safe at School	Strongly Agree					(ref)
	Agree					1.54 (1.24 - 1.92)
	Disagree					2.82 (2.15 - 3.70)
	Strongly Disagree					2.69 (1.85 - 3.91)

Model 1: Final Model Adjusted for Confounders, Model 2: Adjusted for Substance Abuse, Model 3: Adjusted for Depressive Symptoms, Model 4: Adjusted for Bullying, Model 5: Adjusted for Safety at School

[1] OR: Odds Ratio [2] CI: Confidence Interval, (ref): Reference Group

Table 5: Logistic Regression Of Educational Attainment With Chronic Health And Neighborhood/School Variables, Assessed From Census Tract-Level And School Surveys

Individual	OR[1] (95% CI)[2] N = Observations	Model 1, n=6795	Model 2, n=6774	Model 3, n=2603	Model 4, n=3471	Model 5, n=3456
Chronic Health Conditions	Ever Had A Chronic Condition	**1.47 (1.22 - 1.76)**	**1.47 (1.23 - 1.77)**	**1.49 (1.09 - 2.04)**	**1.46 (1.12 - 1.91)**	**1.47 (1.12 - 1.92)**
	Never Reporting A Chronic Condition	(ref)	(ref)	(ref)	(ref)	(ref)
Race/Ethnicity	Black or Mixed Race, Non-Hispanic	1.21 (0.94 - 1.56)	1.05 (0.81 - 1.37)	1.06 (0.69 - 1.63)	1.01 (0.70 - 1.45)	0.90 (0.62 - 1.31)
	Hispanic	0.98 (0.75 - 1.28)	0.88 (0.67 - 1.16)	1.16 (0.78 - 1.73)	0.91 (0.63 - 1.31)	0.91 (0.63 - 1.32)
	Non-Black, Non-Hispanic	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.73 (0.62 - 0.86)	0.74 (0.63 - 0.86)	0.59 (0.46 - 0.75)	0.59 (0.47 - 0.75)	0.59 (0.47 - 0.75)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (1.00 - 1.01)	1.00 (1.00 - 1.00)	0.99 (0.98 - 1.01)	1.00 (0.99 - 1.01)	1.00 (0.99 - 1.01)
Family						
Parent Education Level		0.76 (0.74 - 0.79)	0.78 (0.75 - 0.80)	0.78 (0.74 - 0.82)	0.76 (0.72 - 0.80)	0.77 (0.73 - 0.82)
2-Parent Household	Yes	0.39 (0.32 - 0.46)	0.39 (0.33 - 0.46)	0.36 (0.25 - 0.51)	0.35 (0.26 - 0.48)	0.36 (0.27 - 0.49)
	No	(ref)	(ref)	(ref)	(ref)	(ref)
School						
Teacher Characteristics	5-Year Teacher Turnover			0.99 (0.99 - 1.00)	0.99 (0.98 - 1.00)	0.99 (0.98 - 1.00)
Teachers with Advanced Degrees	Greater Than Mean			1.31 (0.97 - 1.77)	1.34 (1.04 - 1.72)	1.33 (1.04 - 1.71)
	Less Or Equal To Mean			(ref)	(ref)	(ref)
School Type	Public			(ref)	(ref)	(ref)
	Private			0.35 (0.12 -1.01)	0.40 (0.18 - 0.89)	0.41 (0.18 - 0.94)
Percentage Truancy	Percentage Truancy			1.01 (1.00 - 1.03)	1.02 (1.00 - 1.03)	1.02 (1.00 - 1.03)
Percentage of Non-Hispanic White	Greater Than Mean			0.79 (0.58 - 1.07)	0.72 (0.56 - 0.94)	0.75 (0.56 - 0.99)
	Less than Mean			(ref)	(ref)	(ref)
Neighborhood						
Neighborhood Income			1.00 (1.00 - 1.00)			1.00 (1.00 - 1.00)
Neighborhood Education			1.01 (1.00 - 1.02)			1.00 (0.99 - 1.01)

Model 1: Adjusted for Confounders, Model 2: Adjusted for Neighborhood Factors, Model 3: Adjusted for School Factors (1997 Schools), Model 4: Adjusted for School Factors (1997 Schools and Additional Schools), Model 5: Adjusted for both Neighborhood and School Factors

[1] OR: Odds Ratio [2] CI: Confidence Interval, (ref): Reference Group

Figure 1: Analytic Sample

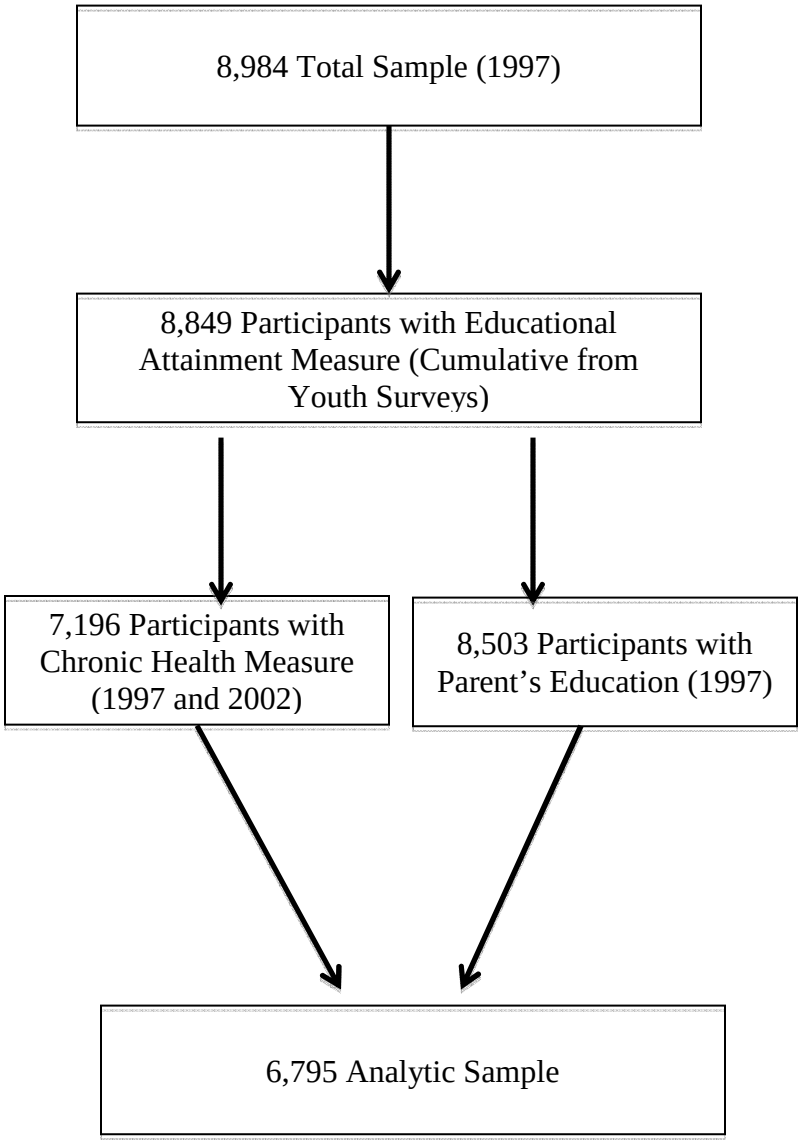


Figure 2: Baron and Kenny Methodology

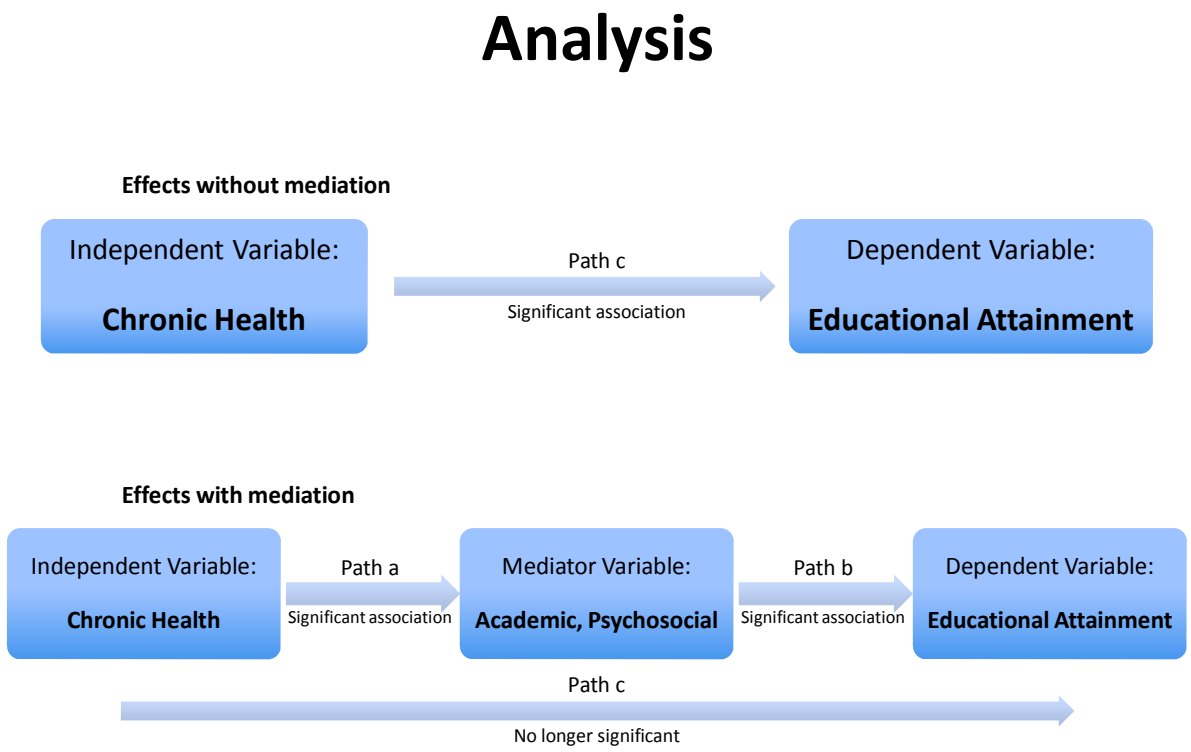
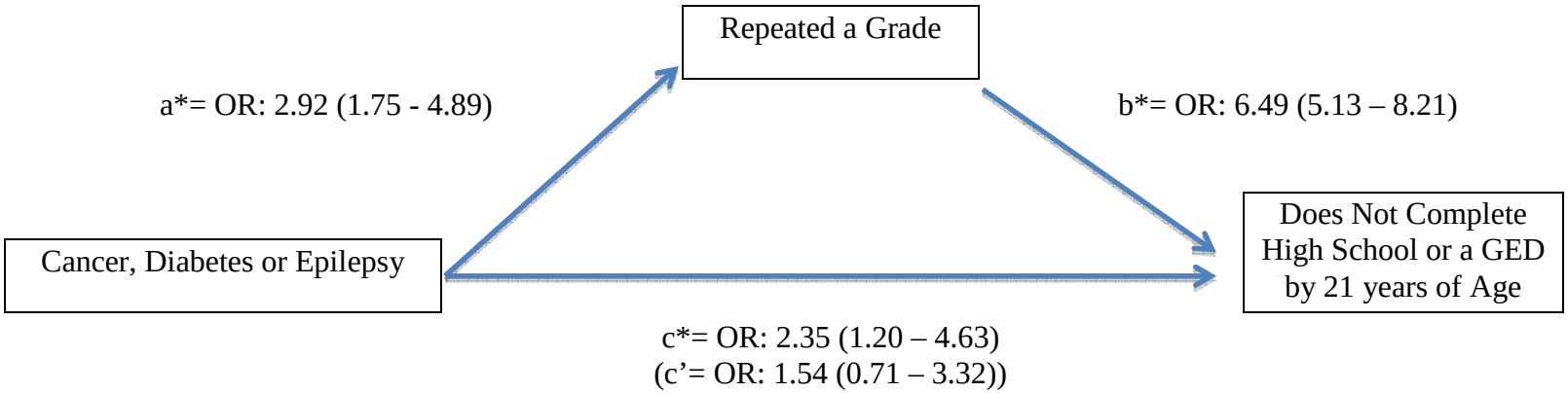
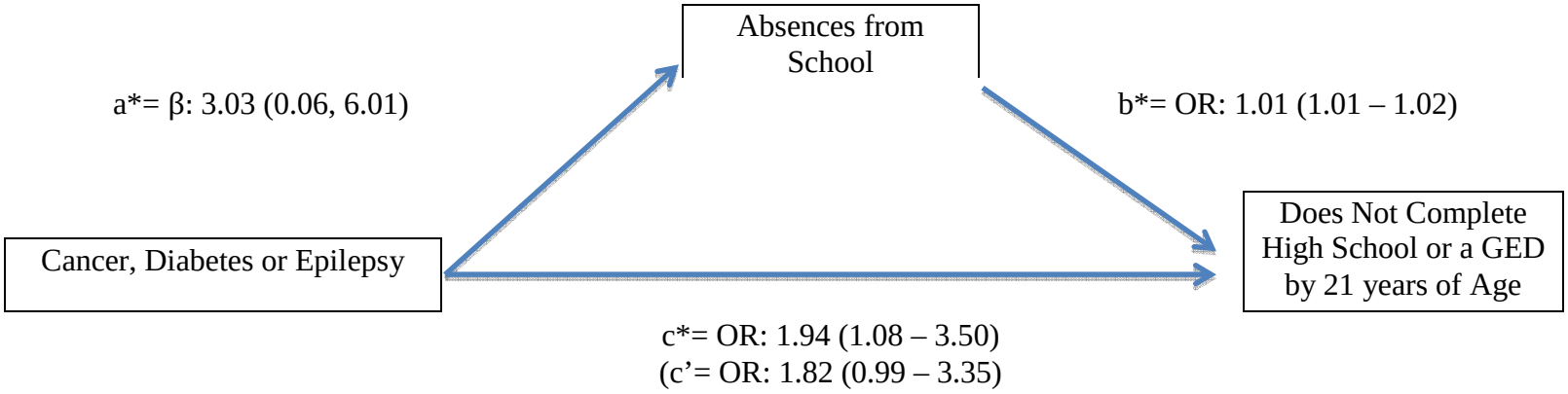


Figure 3A: Repeated Grade Mediation: Paths (n=5115)



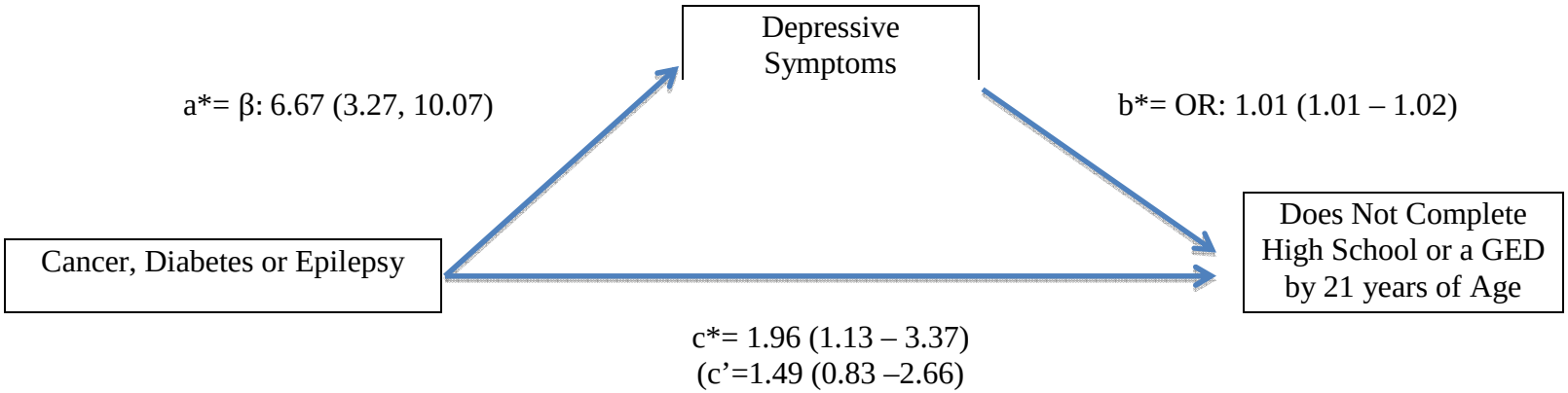
* p <0.05, c': pathway c with mediator introduced, GED: Graduate Equivalency Degree, OR: Odds Ratio
All Paths are adjusting for parent's education, race/ethnicity, gender, age, and 2-Parent Household
Sobel Test : z-test: 2.38 (p-value= 0.02)

Figure 3B: Absences from School Mediation: Paths (n=6634)



* p <0.05, c': pathway c with mediator introduced, GED: Graduate Equivalency Degree, OR: Odds Ratio, β: parameter estimates
All Paths are adjusting for parent's education, race/ethnicity, gender, age, and 2-Parent Household
Sobel Test : z-test: 1.86 (p-value=0.06)

Figure 3C: Depressive Symptoms Mediation: Paths (n=6742)



* p <0.05, c': pathway c with mediator introduced, GED: Graduate Equivalency Degree, OR: Odds Ratio, β: parameter estimates
All Paths are adjusting for parent's education, race/ethnicity, gender, age, and 2-Parent Household
Sobel Test: z-test: 3.86 (p-value<0.01)

Chapter 4: Manuscript 2

Youth Limited by and/or Having Early Onset of Childhood and Adolescent Chronic Health Condition and Educational Attainment

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Manuscript type: Original Research

Key Words: early onset, limited, chronic health conditions, educational attainment,

Word Count: Abstract: 247, Manuscript: 5,302

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Abstract

Background: Among youth with chronic health conditions, we examined the timing of the onset of chronic health conditions and the extent of their limitations to elucidate the impact that each measure has on educational attainment. We incorporated factors from the individual's family, school and neighborhood.

Methods: The National Longitudinal Survey of Youth – 1997 (n=8984), a nationally representative cohort of 12-16 year olds formed in 1997 was used for this analysis. Multivariate logistic regression models were fit to estimate the association for youth limited by and/or onset of a chronic health condition and educational attainment.

Results: Overall 22% of the sample had a chronic health condition; 37% of whom reported a limiting condition. Youth who reported that they were limited by a chronic health condition were significantly less likely to complete high school or a Graduate Equivalency Degree (GED) by 21 years old compared to youth without a condition, OR: 1.76 (95% CI: 1.33 - 2.34). The odds of poor educational attainment for youth who had early onset (12 years or younger) were significantly higher compared to youth without a condition, OR: 1.61 (95% CI: 1.29 – 1.99). Different academic and psychosocial factors attenuated the significant associations found. School factors were important for youth with early onset.

Conclusion: Youth who are limited by or have early onset of chronic health conditions are at a particularly high risk for not completing high school. Each measure showed different mitigating factors from the youth's environment as well as psychosocial and academic indicators.

INTRODUCTION

As medical technology is improving, more children are living longer with more severe chronic health conditions [1]. An estimated 95% of children with a chronic health condition are now living past 20 years of age [2-4]. Recent studies have shown an association with chronic health conditions and poorer educational outcomes [5 - 11]. In a 2011 U.S. study, authors concluded that both young adults who had asthma and young adults who had other chronic health conditions (e.g., cancer, diabetes and epilepsy) were less likely to graduate high school compared to healthy young adults [5]. Our past work has also determined an association with overall chronic health conditions and poor educational attainment [12].

Youth with chronic health conditions vary with respect to how each condition is associated with educational attainment. For example, youth who are limited by a condition or have had their condition for a long period (i.e., early onset) may be at higher risk. Studies that have grouped chronic health conditions together have shown that the impact on educational outcomes for childhood onset (<18 years of age) may be similar across certain health conditions [6, 11]. Longitudinal studies for specific childhood onset chronic health conditions such as cancer and epilepsy have separately shown similar poor social and educational outcomes [9, 10]. A recent U.S. nationally representative cohort study showed that adult onset (18 or over) chronic health conditions were less strongly associated with poor educational outcomes than childhood onset chronic health conditions [6]. Moreover, it was concluded that specific factors that lead to educational differences faced by those with childhood-onset chronic illness are important for future study [6].

Research has also examined the association between early childhood onset of specific chronic health conditions and poor academic achievement. In a small cross sectional Finnish study of children with type 1 diabetes, it was determined that early onset, defined as 5 years or younger, had poorer academic skills compared to children without diabetes independently of a history of severe hypoglycemia and diabetic ketoacidosis [13]. The researchers concluded that those children with early onset of diabetes had an increased risk of learning problems [13]. However, findings from a cross-sectional study conducted in Iowa did not show differences in academic achievement for early or later onset type 1 diabetes [14]. These studies showed mixed results but were each limited in scope. Understanding the association of early childhood onset of chronic health conditions and poor educational attainment may clarify the impact of this potentially high-risk group on a youth's educational attainment.

Past research has shown that inclusion of milder conditions may attenuate the association of poor adult educational and social outcomes [11]. Previous literature has shown that less severe cases of asthma do not affect educational outcomes as much as moderate or severe cases [7, 8]. A study confirmed that there was a need to assess asthma severity levels, as young adults who had non-asthmatic chronic health conditions had worse high school or Graduate Equivalency Degree (GED) completion compared to young adults who had asthma in general [5].

Disease-specific studies also show the importance of degree of a chronic health condition and its effect on poor educational achievement. Children with poorly controlled type 1 diabetes had lower grade point averages, reading scores and an overall lower acquisition of academic skills compared to children with average control [13, 14].

For boys with seizure disorders, those with the greatest severity were at the most risk of academic achievement-related problems [15]. Finally, in a British cancer survivor study it was shown that students with specific types of cancers, particularly cancers that target the central nervous system, achieve an educational attainment that is lower than that of the general population [10]. Although the degree of the chronic health condition appears to be important for educational outcomes, there is little research on youth who report being limited by a chronic health condition and how the limitations may affect educational attainment.

In a major review of the literature, Rumberger suggested a framework for studying student academic performance [16]. According to this framework, the family, school and neighborhood influence a student's performance during all time periods. Understanding a student's completion in high school requires identifying contextual factors from the family, neighborhood and school. Additionally, these factors may be critical for the management of chronic health conditions. These critical influences may allow an afflicted person to cope better with major stressors and contribute to overall school achievement [16, 17, 18].

We examined the association of youth limited by a chronic health condition and/or who had early onset of a chronic health condition and educational attainment. These measures may prove to be better identifiers of poor educational attainment compared to only considering the presence or type of chronic health condition.

METHODS

Study Sample

The National Longitudinal Survey of Youth – 1997 (NLSY'97), a cohort of 8,984 youths aged 12 to 16, was used in this secondary data analysis [19]. Parental and youth one-hour interviews were administered in 1997 and the youth continued to be interviewed on an annual basis through 2009 [20]. Other information for this study came from participant's transcripts, surveys of the school that the participant attended and records of the participant's residence on the census tract level. Variables in our dataset were included through 2009 [20].

Measures

Exposure – Onset of a chronic health condition and youth limited by a chronic health condition were assessed by the parent survey in 1997 and participant survey in 2002. The 1997 parent survey asked whether the participant ever had a condition. The 2002 survey asked whether they ever had been diagnosed with a chronic health condition. Each reported if he or she was currently limited by the chronic health condition. The parent survey asked when the chronic health condition was first noticed and in 2002 the youth survey asked when the chronic health condition was first diagnosed. We did not consider those that reported allergies, STDs, anemia and infectious diseases other then HIV as chronic health conditions in this analysis based on prior literature and our past work [12, 21].

Onset of a chronic health condition was estimated by when the condition was first noticed (1997) or diagnosed (2002). The earliest age reported for any chronic health condition was used. The 75th percentile from this distribution was defined as early onset

(when 12 years of age or younger). This point represents the transition of elementary school to middle school. The American Academy of Pediatrics reports stages of development that separates gradeschool (5 – 12 years) from teen (12 years – 18 years) [22]. Youth who identified a chronic condition after 12 years of age were classified as later onset. Youth who did not report a chronic health condition were the comparison group.

Youth limited by a chronic health condition were determined by whether the chronic health condition limited the participant "a lot" or "a little." The combination of "a lot" or "a little" was based on sample size constraints. If the chronic health condition did not limit the participant during these time periods, he or she was classified as not limited by the chronic health condition. Youth who did not report a chronic health condition comprised the comparison group.

Finally, a unified measure was developed that included both onset of a chronic health condition and youth limited by a chronic health condition. When each criterion was met, these participants were classified as limited and had early onset. Those participants who were either limited by a chronic health condition or had early onset of the chronic health condition, but not both, were separately categorized. Youth who were not limited by a chronic health condition and had later onset of a chronic health condition were also independently categorized. Overall, there were four categories: (1) limited and had early onset, (2) limited by or had early onset of the chronic health condition (3) not limited by and later onset of a chronic health condition, and (4) never reporting a chronic health condition.

Outcome – Educational attainment was operationalized by completion of a high school degree or Graduate Equivalency Degree (GED) by 21 years of age. The participant was asked throughout the follow-up period when or if he or she graduated.

Covariates – Individual level control variables were obtained from the youth and parent surveys. Individual level academic variables were obtained from transcripts and the youth surveys. Individual level psychosocial variables were obtained from the youth surveys. School variables were obtained from school surveys on-site at the Bureau of Labor Statistics. Neighborhood level variables were also obtained on-site from the census tract in which the participant resided in 1997.

Individual Level - Control Variables

Core control variables that were used throughout the analysis included: (1) participant's age in 1997, (2) participant's gender, (3) participant's race/ethnicity and (4) parent education level. These variables were assessed in the baseline year (1997). The following categories were used for a participant's race/ethnicity: (1) Black, Non-Hispanic, (2) Hispanic, (3) Mixed Race, Non-Hispanic, and (4) Non-Black, Non-Hispanic. The mixed race, Non-Hispanic category comprises 1% of the sample. Consequently, this category was added to the Black, Non-Hispanic category. The highest grade that either the mother or father completed was used to assess parent education level irrespective of whether the parent is currently living with the participant. Responses ranged from 0 (no prior education) to 20 (8 or more years of college). Whether the family was a 2-parent household was also considered a confounder in the analysis.

Individual Level -- Academic Variables

Grade point average was obtained from high school transcripts. This information was collected for the older participants in 2000. The remaining participants as well as some of the missing transcripts from the previous collection were obtained in 2004. The Carnegie weighting system was used to weight the participant's grades by the quality of credits received and scores ranged from 0.0 to 5.0.

Whether a participant repeated a grade was assessed from the reported number of grades repeated from elementary school, middle school and high school. This was a cumulative measure developed by survey staff that incorporated the parent survey and follow up rounds from the youth surveys. This variable was binary and was assessed as "Never Repeated a Grade" or "Repeated a Grade."

Individual Level -- Psychosocial Variables

The depressive symptoms score were calculated from the participant's score on the Mental Health Inventory – 5 (MHI-5) collected in 2000 [23, 24]. A higher score indicated more depressive symptoms [23]. This inventory cannot be used for a depression diagnosis [23]. If there was a missing value for one of the 2000 questions, the 2002 score on the same question was added to the overall depressive symptoms score. The MHI-5 has a Cronbach alpha of 0.82 [25, 26].

The substance abuse variable was constructed with the questions: if the participant ever smoked, ever drank alcohol or ever used marijuana from the 1997 youth survey. There were three categories created: (1) used all three, (2) used at least one and (3) used none.

A participant felt safe at the school was operationalized from the 1997 youth survey that asked, "Do you feel safe at school?"

Community Level – Neighborhood

Neighborhood level variables were defined from the census tract that the participant resided in 1997. Neighborhood education was operationalized by the percentage of people within their neighborhood who do not have a high school degree based on 2000 Census data [27]. Neighborhood income was measured by the median household income of the census tract in 1999. These variables were analyzed continuously.

Community Level – School

The National Opinion Research Center (NORC) created surveys for all schools with a 12^{th} grade within each National Longitudinal Survey of Youth primary sampling unit in 1996. School surveys were sent to the principal of each school in 1996. The original schools as well as any additional schools participants attended were surveyed with a separate questionnaire in 2000. Variables were developed first from the 1996 surveys but if values were missing, the 2000 survey was used. School identification numbers were linked to the school that the students attended in 1997. If this school was not available, the following school that the student attended was used.

School type was classified as (1) public and (2) private. The reported percentage truancy was used to describe the overall environment. Racial composition of the school was assessed by the percentage of Non-Hispanic White students. Teacher characteristics were examined by 5-year teacher turnover and the percentage of teachers with advanced degrees. To estimate 5-year teacher turnover, the percentage of teachers at the school who had taught there five years earlier was used. Percent of Non-Hispanic White

students and percent of teachers with advanced degrees were collapsed into binary variables based on the mean. Higher and lower groups better represented their associations with educational attainment based on prior literature and analysis of these variables continuously [28].

Analysis

Descriptive statistics of the sample's onset of chronic health conditions, youth limited by chronic health conditions, as well as limited and had early onset were conducted. Each of these variables and covariates were compared to the completion of high school or a GED by bivariate analysis using chi-square and t-tests. Multivariate logistic regression was used to estimate the association for youth limited by a chronic health condition, onset of chronic health conditions, limited and had early onset and high school or GED completion by 21 years of age adjusting for control variables and exploring the influences of the youth's neighborhood and school as well as academic and psychosocial factors. Multiple models were fit implementing SAS 9.2 (SAS Institute, Cary, NC). Our final model's analytic sample was n= 6,738 for onset (Figure 1) and n=6,701 for our limited measure (Figure 2). We used proc surveylogistic to estimate odds ratios and 95% confidence intervals. All models controlled for the complex survey design of the NLSY '97 by using customized survey weights, primary sampling units and strata.

The school analyses had many missing values. Based on bivariate analyses comparing missing values to non-missing values, the exposure variables used were not significantly different. However in each case the analytic sample was older (by close to 14 months), had more educated parents (by less then half a grade) and had more Non-Black, Non-Hispanics (by close to 3 percent).

Final Models

School, neighborhood, academic and psychosocial variables were separately added to the model. Academic and psychosocial variables were added to the model based on prior literature and consideration of sample size and model fit [29]. To the best of our knowledge, neighborhood and school factors have not been used to examine the association of chronic health conditions and poor educational attainment. Consequently, we examined a series of neighborhood and school variables. A forward selection was conducted to limit these variables in the model. This model selection was conducted using proc surveylogistic based on a SAS macro from Wang and Shin [30]. A forward selection was implemented because we wanted to test the significance of new variables based on addition to our robust model.

RESULTS

Table 1 includes sociodemographic characteristics for the whole sample, frequencies of the exposure measures and bivariate analyses with the poor educational attainment outcome. Overall, 22% of the sample reported a chronic health condition and 8% were limited by a chronic health condition. Fourteen percent of the sample had a chronic health condition with early onset, and 6% of the sample was both limited and had early onset of their chronic health condition. Fifteen percent of the sample did not complete a high school degree or a GED by 21 years of age. Among youth limited by a chronic health condition, 17% did not complete a high school degree or a GED by 21 years of age (12% of poor educational attainment participants). For youth who had early onset of a chronic health condition, 16% did not complete a high school degree or a GED by 21 years of age (19% of poor educational attainment participants). Among youth limited

and had early onset, 18% did not complete a high school degree or a GED by 21 years of age (9% of poor educational attainment participants).

Among youth who reported ever having asthma, 46% were limited, 83% reported early onset and 38% were limited and had early onset. Among youth who reported cancer, diabetes, or epilepsy, 39% were limited, 59% reported early onset and 25% were limited and had early onset. Among youth who reported heart conditions, 40% were limited, 76% reported early onset and 27% were limited and had early onset.

Tables 2 – 4 show the results of logistic regression in the association of youth limited (Table 2), had early onset (Table 3) and limited and had early onset (Table 4) and poor educational attainment. The models presented diverge slightly for all three tables to better represent the factors influencing each measure. Generally, Model 1 and Model 2 estimated the associations of youth limited, youth with early onset or youth limited and had early onset and poor educational attainment adjusting for confounders. Models 3 through 5 additionally adjusted for academic variables or psychosocial variables. The final models (Model 6 and Model 7) adjusted for neighborhood and school variables. The specific results from our tables are presented below.

Youth Limited by a Chronic Health Condition

In Model 2.1, the odds of not completing a high school diploma or a GED by 21 years of age were higher for youth limited by a chronic health condition, OR: 1.76 (95% CI: 1.33 - 2.34) compared to youth without a chronic health condition adjusting for demographic variables. For youth not limited by a chronic health condition, the odds of not completing a high school diploma or a GED by 21 years of age were not significantly different when compared to youth without a condition, OR: 1.06 (95% CI: 0.82 – 1.35).

Whether or not the family was a 2-parent household was added to Model 2.2. The association remained significant for youth limited by a chronic health condition and poor educational attainment, OR: 1.70 (95% CI: 1.27 - 2.28). It should be noted that youth limited by their chronic health condition had significantly higher odds of poor educational attainment compared to only youth that were not limited by their chronic health condition adjusting for all factors in Model 2.2 (not reported in tables: n=1217), p-value = 0.02, OR: 1.57 (95% CI: 1.09 – 2.27).

In Model 2.3, we estimated being limited by a chronic health condition and poor educational attainment examining the influences of those participants who repeated a grade. The association for youth limited by a chronic health condition and poor educational attainment was reduced but still significant, OR: 1.57 (95% CI: 1.11 - 2.21). It should also be noted that when other academic variables were added separately, such as grade point average, the association between youth limited by a chronic health conditions and educational attainment were only slightly attenuated (not reported in tables).

When psychosocial variables (depressive symptoms score, felt safe at school, substance abuse) were separately added to the model, the previous association between youth limited by a chronic health condition and poor educational attainment was attenuated but still remained significant, OR: 1.56 (95% CI: 1.15 - 2.12). In Model 2.5, we added both psychosocial, and academic variables, and the association was no longer significant, OR: 1.39 (95% CI: 0.96 - 2.00). For Model 2.6, we added neighborhood and school variables separately from academic and psychosocial variables, and the association was significant. The final model added the percentage truancy at the school

to the other school and neighborhood level variables, which increased the odds of the association to 1.73 (95% CI 1.13 - 2.65).

Onset of a Chronic Health Condition

Seven models are provided in Table 3. In Model 3.1 it was found that the odds of not completing a high school diploma or a GED by 21 years of age were higher for youth with chronic health conditions that was early onset, OR: 1.61 (95% CI: 1.29 – 1.99) compared to youth without a chronic health condition, when adjusting for demographic variables. Youth with later onset of a chronic condition, at 13 years of age or older, also had higher odds of poor educational attainment, OR: 1.42 (95% CI: 1.00 – 2.02) compared to youth without a condition. The next model estimated onset of chronic health conditions and poor educational attainment while adjusting for whether the family was a 2-parent household. The association with early onset and poor educational attainment still remained significant, OR: 1.61 (95% CI: 1.28 - 2.01). In this model, later onset of a chronic health condition did not have significantly higher odds of poor educational attainment compared to youth without a condition, OR: 1.35 (95% CI: 0.94 - 1.94). It should be noted that when we compared youth with early onset to only youth with later onset (n=1254) adjusting for all factors in Model 3.2 (not reported), there was a 28% higher odds of poor educational attainment but this association was not significant, p-value = 0.21, OR: 1.28 (95% CI: 0.87 – 1.90).

In Model 3.3, we added the variable repeated a grade to the association between onset of chronic health conditions and poor educational attainment. Participants with early onset of a chronic health condition still had higher odds of poor educational attainment, OR: 1.87 (95% CI: 1.43 – 2.43). For Model 3.4, high school grade point

average was added and for youth with early onset of a chronic health condition, the odds for poor educational attainment was no longer significantly different as compared to youth without a condition, OR: 1.35 (95% CI: 0.90 – 2.02).

When psychosocial variables were added to the model, the association between early onset of chronic health conditions and poor educational attainment was attenuated but still significant, (Model 3.5, OR: 1.28, (95% CI: 1.00 – 1.65)). We then adjusted for both academic and psychosocial variables and the odds of poor educational attainment for early onset was no longer significant, OR: 1.15 (95% CI: 0.77 - 1.72). In Model 3.7, we adjusted for neighborhood and school level variables. The association was attenuated, OR: 1.45 (95% CI: 1.02 – 2.07) but for later onset chronic conditions the association with poor educational attainment remained, OR: 1.70 (95% CI: 1.04 – 2.77).

Youth Limited and Had Early Onset

In Table 4, the results of the association between youth with early onset of a chronic health condition and youth limited by a chronic health condition and educational attainment are presented. It was found that youth limited and had early onset had higher odds of not completing a high school diploma or a GED by 21 years of age, OR: 1.74 (95%: 1.24 – 2.43) compared to youth without a chronic health condition when adjusting for demographic variables (Model 4.1). The results were similar for academic and psychosocial variables as in the above analysis. School and neighborhood variables, with the exception of percentage truancy, did not affect this association found (Model 4.5). It was also found that the odds of poor educational attainment were higher for youth who were both limited and had early onset of a chronic health condition, OR: 1.96 (95% CI:

1.22 – 3.17) compared to who did not report a chronic health condition adjusting for percentage truancy and all other school and neighborhood level variables (Model 4.6).

DISCUSSION

Overall, being limited by a chronic health condition and having early onset of a chronic health condition both significantly elevated the odds of not completing high school or obtaining a GED by 21 years of age compared to youth who did not report a chronic health condition. These findings support existing literature that youth who had a chronic health condition before the age of 18 have poor educational outcomes [5 - 11]. As life expectancy improves for children with chronic health conditions, these children are at an increased risk of poor educational attainment [2-4].

This study differs from previous work in that our sample was a younger adolescent population and we included youth with asthma in our analysis [5-11]. Our measure of early onset was when conditions were reported before the age of 13 whereas prior studies used before the age of 18. We identified important factors for onset of chronic health conditions as well as for youth who were limited by a chronic health condition. In our past work, an association was established between the presence of chronic health conditions and poor educational attainment. In this study, we expanded upon previous research by identifying high-risk groups with chronic health conditions that were better overall measures for predicting poor educational attainment.

Family socioeconomic status particularly poverty has been shown to be the most important predictor for school performance [16]. This study adjusted for socioeconomic status at baseline. Youth could have experienced poverty prior to our study. This may have an influence on the likelihood of ever having a chronic health condition and poor

attainment. Early onset of a chronic health condition combined with early life poverty could further increase the burden on the child and lead to a higher amount of poor educational attainment. Youth that have been poor over time and have developed a chronic health condition may have poorer treatment options. This could lead to more limiting chronic health conditions.

Youth who had later onset also had a significant increase in the odds of not completing high school or obtaining a GED by 21 years of age. However, the odds of poor educational attainment were higher for youth who had early onset of a chronic health condition compared to youth who had later onset of a condition.

Eighty one percent of individuals who had a chronic health condition with early onset were youth with asthma, whereas forty nine percent of youth with later onset reported having asthma. Past literature has shown that asthma is a less severe condition compared to other chronic health conditions [6]. Despite the past literature and the difference in composition, youth with early onset still had worse educational outcomes compared to later onset. Early onset for youth with asthma and other chronic health conditions may suffer from a cumulative effect over time. For example, youth with asthma have more trouble sleeping and are more likely to miss classes [31]. The cumulative impact from these afflictions may affect development more compared to later onset. These results are important because they demonstrate that not only does the type of chronic health condition affect poor educational attainment but the timing of the onset does as well.

Youth limited by a chronic health condition had higher odds ratios of poor educational attainment compared to youth with early onset. Also, the odds ratios for

youth who were limited and had early onset of a chronic health condition were only slightly higher compared to youth limited by a condition. These results suggest that being limited by a chronic condition may be a better indicator of elevated risk of poor educational attainment compared to early onset.

Youth limited by a chronic health condition included those who were either limited “a little” or “a lot" by a chronic health condition, and among individuals who were limited by a chronic health condition, 74% were youth with asthma. As noted earlier, it has been shown that milder conditions may attenuate the effect on chronic health conditions and poor adult outcomes, particularly for youth with mild asthma [6, 8, 11]. It has been suggested that the milder the condition, the less of an effect on adolescent development [32]. These findings suggest that being limited by a chronic health condition is an important parameter for youth with asthma when identifying those at risk of poor educational attainment. Youth were also limited by non-asthmatic chronic health conditions and the significantly higher odds of poor educational attainment confirms other disease specific associations from the literature including cancer, diabetes, and epilepsy and their poor educational outcomes [10, 13 - 15]. For example, in cross-sectional studies it was found that student’s who controlled their diabetes so that it no longer limited them was essential to achievement and attainment [13, 14].

When academic variables and psychosocial variables were both added in the model, the association of youth who were limited by a chronic condition and poorer educational attainment was no longer statistically significant. This occurred for onset as well. These results are similar to the Haas and Fosse study that showed the association of

self-reported health and educational attainment among adolescents was attenuated by academic and psychosocial factors [29].

However, it was also shown that each onset or limited measure's association with poor educational attainment was uniquely influenced by the specific academic factors added. Understanding these variations may aid in better strategies to prevent poor educational attainment for each high-risk group. For example, the variable repeated a grade attenuated the association for youth limited by a chronic health condition and poor educational attainment but not for the association with early onset of a chronic health condition and poor educational attainment. This suggests that the association for youth limited by a chronic health condition and poor educational attainment was more affected by grade repetition compared to the association with early onset of a chronic health condition and poor educational attainment. Similarly, the association for youth with early onset of a chronic health condition and poor educational attainment was more affected by grade point average compared to the association with youth limited by a chronic health condition and poor educational attainment.

It appeared that the school had an important effect on the association of early onset of chronic health conditions and poor educational attainment. This suggests that school selection is important for those participants with chronic health conditions early in life. These findings have not been examined previously. However in a recent study, a participant's connectedness to school was a significant factor in the association of those with childhood chronic health conditions and college graduation [33]. School characteristics, programs and policies may promote school connectedness. Specific health programs such as homebound instruction, counseling services and school policies

need to be further studied. Determining these programs effects on maintaining academic standing may be critical. The American Academy of Pediatrics recommend parents make the school aware of their child's chronic health condition and develop a plan with the school that outlines the child's needs and goals [34]. Potential effect modification with school factors and chronic health conditions merits study.

Strengths of this study included that we were able to use a large, nationally representative dataset that had many measures from exceptional sources including youth's transcripts. This allowed us to examine many potential high-risk groups as well as factors that contribute to each association with poor educational attainment.

Study limitations included that it was a secondary analysis. Each of the self-reported surveys may be subject to measurement error. The parent survey (1997), a self-reported identification of chronic health conditions is problematic because those parents who are more involved and knowledgeable of health issues may be more aware of the participant's health. These parents would likely report a chronic health condition more often. Onset of a chronic health condition was defined as when it was first noticed in 1997 and when it was first diagnosed in 2002, which are subject to variation. These questions may capture distinct populations.

In conclusion, youth limited by chronic health conditions, and early onset of a chronic health condition had poor educational attainment. Parents and teachers of children of these groups need to be aware of the risk of poor educational attainment. Diagnosis and treatment of chronic health conditions is extremely important not only to a student's health but also their education. These students may also benefit the most from a school with superior school characteristics. However, future research should examine

specific school programs and policies such as home schooling and other support. Further study of the academic and psychosocial factors identified may ultimately help to prevent these youth from having a poor educational attainment or allow them to maintain a positive educational course.

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Table 1: Weighted Sample Characteristics Of The National Longitudinal Survey of Youth – Cohort 1997 By Completion Of A High School Degree Or Graduate Equivalency Degree By 21 Years of Age

	Overall n=8984 %[1] Or Mean (SE[2])	Completed A HSD[3] Or GED[4] By 21 Years Of Age, (%) n=7286	Did Not Attain A HSD Or GED By 21 Years Of Age, (%) n=1563	p-value
Variable, Sample Size	100%	84.55%	15.45%	
Exposure				
Exposure				
Chronic Health Condition (%) n=7196				
Did Not Ever Have A Chronic Health Condition	77.83%	78.65%	72.46%	χ^2: p<0.01
Ever Had A Chronic Health Condition	22.17%	21.35%	27.54%	
Limited By The Chronic Health Condition (%) n=7098				
Limited A Lot/A Little	8.30%	7.82%	11.97%	
Not Limited	10.50%	10.46%	10.10%	χ2: p<0.01
Does Not Report Condition	81.20%	81.71%	77.94%	
Onset (%) n=7134				
Early Onset (12 and younger)	14.48%	13.83%	19.09%	
Later Onset (13 and older)	4.91%	4.76%	5.67%	χ2: p<0.01
Does Not Report Condition	80.61%	81.41%	75.24%	
Limited And Onset (%) n=7044				
Early Onset And Limited A Lot/A Little	6.01%	5.61%	8.96%	
Early Onset Or Limited A Lot/A Little	9.62%	9.62%	9.59%	χ2: p<0.01
Not Limited and Later Onset	2.61%	2.50%	2.94%	
Does Not Report Condition	81.76%	82.27%	78.51%	
Individual – Student Background				
Age- January 1, 1997 (n=8984)	14.54 (0.02)	14.55 (0.02)	14.54 (0.04)	t: p=0.86
Race/Ethnicity (%) n=8984				
Black, Non-Hispanic	15.40%	14.16%	21.31%	
Hispanic	12.86%	11.80%	18.26%	χ^2: p<0.01
Mixed Race, Non-Hispanic	1.23%	1.25%	0.88%	
Non-Black, Non-Hispanic	70.50%	72.78%	59.55%	

Gender (%) n=8984				
Male	51.32%	50.36%	55.74%	χ^2: p<0.01
Female	48.68%	49.64%	44.26%	
Individual – Family				
Parent's Education Level (Highest Grade) n=8503	13.58 (0.09)	13.88 (0.09)	12.00 (0.10)	t: p<0.01
2-Parent Household (%) n=8984				
No	47.06%	43.35%	65.45%	χ^2: p<0.01
Yes	52.94%	56.65%	34.55%	
Individual – Psychosocial				
Depressive Symptoms (n=8417)	31.24 (0.23)	30.69 (0.22)	34.34 (0.67)	t: p<0.01
Substance Abuse (%) n=8950				
Ever Used Alcohol, Smoked And Used Marijuana	17.74%	16.26%	24.63%	χ^2: p<0.01
Ever Used Alcohol Or Smoked Or Used Marijuana	37.94%	38.04%	37.77%	
Did Not Use Any Of The Above	44.32%	45.69%	37.61%	
Felt Safe At School (%) n=8959				
Strongly Agree	34.24%	36.36%	23.69%	
Agree	53.12%	52.95%	53.66%	χ^2: p<0.01
Disagree	9.94%	8.46%	17.67%	
Strongly Disagree	2.70%	2.23%	4.98%	
Individual – Academic				
Ever Repeated A Grade (%) n=5943				
Never Repeated A Grade	82.40%	86.87%	52.02%	χ^2: p<0.01
Repeated A Grade	17.60%	13.13%	47.98%	
2 Or More Repeated Grades	2.96%	1.73%	36.68%	χ^2: p<0.01
1 Repeated Grade	14.64%	11.41%	11.30%	
Grade Point Average (n= 6155)	2.82 (0.02)	2.90 (0.02)	2.14 (0.04)	t: p<0.01
Community – Neighborhood				
Neighborhood Income (n=8959)	$44,894 ($1,287)	$46,022 ($1,386)	$39,178 ($845)	t: p<0.01

Community – School				
Type of School (%) n=5223				
Public School	91.69%	90.90%	96.58%	χ^2: p<0.01
Private School	8.31%	9.10%	3.42%	
Percentage of Non-Hispanic White (%) n=5224				
Greater Than Or Equal To Mean	62.46%	64.33%	50.32%	χ^2: p<0.01
Less Than Mean	37.54%	35.68%	49.68%	
Percentage of Teachers with Advanced Degrees (%) n=5083				
Greater Than Or Equal To Mean	52.89%	52.62%	54.07%	χ^2: p=0.55
Less Than Mean	47.11%	47.38%	45.93%	
5 Year Teacher Turnover (n= 5106)	83.10% (0.59)	83.35% (0.60)	81.25% (0.91)	t: p=0.01
Percentage Truancy (n=4847)	3.96% (0.30)	3.78% (0.33)	4.98% (0.33)	t: p<0.01

[1] %: Percentage [2] SE: Standard Error [3] HSD: High School Diploma [4] GED: Graduate Equivalency Degree

Table 2: Logistic Regression Of Youth Limited By Chronic Health Condition And Poor Educational Attainment

(Did Not Complete High School Or Graduate Equivalency Degree By 21 Years Of Age)

Individual	OR[1] 95% CI[2] n= Observations	Model 1, n=6701	Model 2, n=6701	Model 3, n= 5039	Model 4, n=6665	Model 5 n=5016	Model 6, n=3658	Model 7, n=3434
Chronic Health Condition	Limited By Condition	**1.76 (1.33 - 2.34)**	**1.70 (1.27 - 2.28)**	**1.57 (1.11 - 2.21)**	**1.56 (1.15 - 2.11)**	1.38 (0.96 - 2.00)	**1.73 (1.13 - 2.65)**	**1.97 (1.30 - 3.00)**
	Not Limited By Condition	1.06 (0.82 - 1.35)	1.05 (0.81 - 1.36)	0.87 (0.61 - 1.25)	0.99 (0.76 - 1.29)	0.83 (0.58 - 1.20)	0.99 (0.69 - 1.43)	0.99 (0.67 - 1.48)
	Does Not Report Condition	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (0.99 - 1.00)	1.00 (1.00 - 1.00)	1.01 (1.00 - 1.01)	1.01 (1.00 - 1.01)	1.02 (1.01 - 1.02)	1.00 (0.99 - 1.01)	1.00 (0.99 - 1.01)
Race/Ethnicity	Black or Mixed Race, Non-Hispanic	1.60 (1.27 - 2.03)	1.25 (0.97 - 1.62)	0.88 (0.73 - 1.43)	1.34 (1.03 - 1.76)	0.97 (0.70 - 1.33)	1.15 (0.82 - 1.63)	1.07 (0.74 - 1.55)
	Hispanic	0.89 (0.66 - 1.20)	0.98 (0.74 - 1.30)	0.76 (0.51 - 1.11)	1.06 (0.80 - 1.39)	0.77 (0.53 - 1.13)	1.11 (0.77 - 1.59)	1.08 (0.74 - 1.58)
	Non-Hispanic, Non-Black	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.75 (0.64 - 0.87)	0.73 (0.62 - 0.85)	0.79 (0.62 - 1.02)	0.68 (0.57 - 0.80)	0.73 (0.56 - 0.95)	0.58 (0.46 - 0.74)	0.58 (0.46 - 0.74)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Family	Parent Education Level	0.73 (0.70 - 0.76)	0.74 (0.72 - 0.78)	0.74 (0.70 - 0.78)	0.75 (0.72 - 0.78)	0.74 (0.70 - 0.78)	0.77 (0.73 - 0.81)	0.77 (0.73 - 0.81)
2-Parent Household	Yes		0.36 (0.30 - 0.43)	0.46 (0.36 - 0.59)	0.41 (0.34 - 0.49)	0.50 (0.39 - 0.65)	0.32 (0.24 - 0.42)	0.33 (0.25 - 0.45)
	No		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Academic - Repeated A Grade	Repeated a Grade			7.11 (5.55 - 9.11)		6.50 (5.03 - 8.39)		
	Never Repeated a Grade			(ref)		(ref)		
School – Teachers with Advanced Degrees	Greater Than Mean						1.30 (1.02 - 1.65)	1.28 (0.99 - 1.66)
	Less Or Equal To Mean						(ref)	(ref)
5-Year Teacher Turnover							0.99 (0.98 - 0.99)	0.99 (0.98 - 0.99)
Percentage Truancy								1.02 (1.01 - 1.04)
School Type	Public						(ref)	(ref)
	Private						0.25 (0.10 - 0.65)	0.28 (0.11 - 0.73)
Neighborhood – Neighborhood Income							1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
Psychosocial	Depressive Symptoms Score				1.01 (1.01 - 1.02)	1.01 (1.00 - 1.02)		
Substance Abuse	Alcohol, Smoking and Marijuana				2.56 (2.03 - 3.22)	2.60 (1.86 - 3.63)		
	Alcohol, Smoking or Marijuana				1.52 (1.26 - 1.83)	1.52 (1.17 - 1.98)		
	Used None				(ref)	(ref)		
Felt Safe At School	Strongly Agree				(ref)	(ref)		
	Agree				1.42 (1.13 - 1.79)	1.32 (0.96 - 1.82)		
	Disagree				2.52 (1.88 - 3.37)	2.26 (1.51 - 3.36)		
	Strongly Disagree				2.28 (1.50 - 3.48)	2.29 (1.18 - 4.43)		

Model 1: Adjusted for Demographic variables, Model 2: Adjusted for 2 Parent Household and Demographic Variables, Model 3: Adjusted for Academic Factors, Model 4: Adjusted for Psychosocial Factors, Model 5 Adjusted for Psychosocial and Academic Factors, Model 6: Adjusted for Neighborhood/ School Factors, Model 7: Added Percent Truancy

[1]OR: Odds Ratio [2] CI: Confidence Interval, (ref): Reference Group

Table 3: Logistic Regression Of Onset Of Chronic Health Condition And Poor Educational Attainment

(Did Not Complete High School Or Graduate Equivalency Degree By 21 Years Of Age)

Individual	OR[1] 95% CI[2] n= Observations	Model 1, n=6738	Model 2, n=6738	Model 3, n= 5075	Model 4, n=3821	Model 5, n=6656	Model 6, n=3796	Model 7, n=3427
Chronic Health Condition	Early Onset	**1.61 (1.29 - 1.99)**	**1.61 (1.28 - 2.01)**	**1.87 (1.43 - 2.43)**	1.35 (0.90 - 2.02)	**1.28 (1.00 - 1.65)**	1.15 (0.77 - 1.72)	**1.45 (1.02 - 2.07)**
	Later Onset	**1.42 (1.00 - 2.02)**	1.35 (0.94 - 1.94)	0.95 (0.59 - 1.52)	0.85 (0.38 - 1.88)	1.20 (0.84 - 1.72)	0.86 (0.37 - 1.99)	**1.70 (1.04 - 2.77)**
	Does Not Report Condition	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (0.99 - 1.00)	1.00 (1.00 - 1.00)	1.01 (1.00 - 1.01)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.01)	1.02 (1.01 - 1.03)	1.00 (0.99 - 1.01)
Race/Ethnicity	Black or Mixed-Race, Non-Hispanic	1.56 (1.24 - 1.97)	1.23 (0.96 - 1.58)	0.85 (0.63 - 1.14)	0.77 (0.51 - 1.15)	1.33 (1.02 - 1.74)	0.87 (0.58 - 1.29)	0.89 (0.62 -1.30)
	Hispanic	0.90 (0.68 - 1.19)	0.98 (0.75 - 1.28)	0.77 (0.53 - 1.11)	0.80 (0.51 - 1.25)	1.04 (0.80 - 1.36)	0.79 (0.49 - 1.26)	0.89 (0.62 - 1.28)
	Non-Hispanic, Non-Black	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.78 (0.67 - 0.91)	0.76 (0.65 - 0.89)	0.86 (0.68 - 1.09)	0.96 (0.69 - 1.33)	0.69 (0.58 - 0.82)	0.83 (0.59 - 1.18)	0.61 (0.48 - 0.77)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Family	Parent Education Level	0.74 (0.71 - 0.77)	0.75 (0.73 - 0.78)	0.75 (0.72 - 0.79)	0.80 (0.74 - 0.85)	0.75 (0.72 - 0.78)	0.78 (0.73 - 0.84)	0.77 (0.73 - 0.81)
2-Parent Household	Yes		0.38 (0.32 - 0.45)	0.49 (0.39 - 0.62)	0.53 (0.38 - 0.75)	0.41 (0.34 - 0.49)	0.56 (0.40 - 0.80)	0.35 (0.26 - 0.48)
	No		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Academic - Ever Repeated A Grade	Repeated A Grade			6.54 (5.13 - 8.34)	4.88 (3.59 - 6.65)		4.82 (3.50 - 6.64)	
	Never Repeated A Grade			(ref)	(ref)		(ref)	
Grade Point Average	(GPA)				0.32 (0.24 - 0.43)		0.33 (0.25 - 0.44)	
School - Percentage of Non-Hispanic Whites	Greater Than Mean							0.75 (0.57 - 0.98)
	Less than Mean							(ref)
Teachers with Advanced Degrees	Greater Than Mean							1.29 (1.00 - 1.65)
	Less Or Equal To Mean							(ref)
5-Year Teacher Turnover								0.99 (0.98 - 1.00)
School Type	Public							(ref)
	Private							0.42 (0.18 - 0.96)
Percentage Truancy								1.02 (1.01 - 1.03)
Neighborhood	Neighborhood Income							1.00 (1.00 - 1.00)
Psychosocial – Substance Abuse	Alcohol, Smoking and Marijuana					2.52 (2.00 - 3.19)	2.27 (1.40 - 3.67)	
	Alcohol, Smoking or Marijuana					1.48 (1.23 - 1.80)	1.52 (1.00 - 2.29)	
	Used None					(ref)	(ref)	
Depressive Symptoms	Score					1.01 (1.01 - 1.02)	1.01 (1.00 - 1.02)	
Felt Safe At School	Strongly Agree					(ref)	(ref)	
	Agree					1.43 (1.13 - 1.80)	1.18 (0.79 - 1.76)	
	Disagree					2.47 (1.84 - 3.31)	1.67 (0.98 - 2.86)	
	Strongly Disagree					2.30 (1.51 - 3.49)	1.93 (0.80 - 4.69)	

Model 1: Adjusted for Demographic variables, Model 2: Adjusted for 2-Parent Household and Demographic Variables, Model 3: Adjusted for Academic Factors, Model 4: Adjusted for GPA, Model 5 Adjusted for Psychosocial, Model 6: Adjusted for Academic and Psychosocial Factors, Model 7: Adjusted for Neighborhood/School Variables [1] OR: Odds Ratio [2] CI: Confidence Interval

Table 4: Logistic Regression of Youth Limited By And Have Early Onset Of Chronic Health Conditions And Poor Attainment

(Did Not Complete High School Or Graduate Equivalency Degree By 21 Years Of Age)

Individual	OR[1] 95% CI[2] n= Observations	Model 1, n=6652	Model 2, n= 3792	Model 3, n=6616	Model 4, n=3782	Model 5, n=3687	Model 6, n=3428
Limited By Chronic Health Condition And Early Onset	Limited And Early Onset	**1.74 (1.24 - 2.43)**	1.55 (0.90 - 2.67)	**1.64 (1.14 - 2.35)**	1.48 (0.85 - 2.58)	**1.74 (1.08 - 2.79)**	**1.96 (1.22 - 3.17)**
	Either Limited Or Has Early	1.16 (0.86 - 1.56)	0.83 (0.44 - 1.55)	1.08 (0.81 - 1.44)	0.86 (0.48 - 1.55)	0.95 (0.59 - 1.53)	1.01 (0.62 - 1.63)
	Not Limited And Not Early	1.23 (0.76 – 2.00)	0.65 (0.24 – 1.82)	1.07 (0.64 -1.80)	0.90 (0.27 – 2.99)	1.41 (0.82 – 2.42)	1.45 (0.83 – 2.53)
	Does Not Report Condition	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Race/Ethnicity	Black and Mixed Race, Non-Hispanic	1.23 (0.95 - 1.58)	.079 (0.52 - 1.21)	1.32 (1.00 - 1.73)	0.90 (0.60 - 1.34)	0.88 (0.61 - 1.27)	0.89 (0.60 - 1.31)
	Hispanic	0.97 (0.73 - 1.28)	0.79 (0.49 - 1.26)	1.04 (0.79 - 1.37)	0.81 (0.51 - 1.30)	0.88 (0.61 - 1.26)	0.92 (0.63 - 1.34)
	Non-Hispanic, Non-Black	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Gender	Female	0.74 (0.63 - .086)	0.95 (0.71 - 1.29)	0.69 (0.58 - 0.82)	0.82 (0.57 - 1.16)	0.62 (0.50 - 0.78)	0.61 (0.48 - 0.77)
	Male	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Age		1.00 (1.00 - 1.00)	1.01 (1.00 - 1.02)	1.01 (1.00 - 1.01)	1.02 (1.01 - 1.03)	1.00 (0.99 - 1.01)	1.00 (0.99 - 1.01)
Family	Parent Education Level	0.74 (0.72 - 0.77)	0.88 (0.63 - 1.24)	0.75 (0.72 - 0.78)	0.79 (0.73 - 0.85)	0.77 (0.73 - 0.81)	0.77 (0.72 - 0.81)
2-Parent Household	Yes	0.35 (0.30 - 0.42)	0.52 (0.36 - 0.74)	0.40 (0.34 - 0.49)	0.57 (0.40 - 0.80)	0.31 (0.24 - 0.41)	0.33 (0.24 - 0.43)
	No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Academic Repeat Grade	Yes		4.96 (3.64 - 6.77)		4.80 (3.49 – 6.62)		
	No		(ref)		(ref)		
Grade Point Average			0.31 (0.24 - 0.41)		0.33 (0.25 - 0.44)		
5-Year Teacher Turnover						0.99 (0.98 - 0.99)	0.99 (0.98 - 0.99)
School Type	Public					(ref)	(ref)
	Private					0.29 (0.12 - 0.69)	0.31 (0.13 - 0.76)
Race of School: Percentage of Non-Hispanic White	Greater Than Mean					(ref)	(ref)
	Less Than Mean					0.71 (0.54 - 0.94)	0.77 (0.58 – 1.03)
Percentage Truancy							1.02 (1.01 – 1.03)
Neighborhood- Income						1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)
Psychosocial – Substance Abuse	Alcohol, Smoking And Marijuana			2.58 (2.05 – 3.26)	2.29 (1.41 – 3.70)		
	Alcohol, Smoking, Or Marijuana			1.51 (1.24 – 1.82)	1.54 (1.02 – 2.33)		
	Used None			(ref)	(ref)		
Depressive Symptoms	Score			1.01 (1.01 – 1.02)	1.01 (1.00 – 1.02)		
Felt Safe At School	Strongly Agree			(ref)	(ref)		
	Agree			1.43 (1.13 - 1.81)	1.17 (0.78 – 1.74)		
	Disagree			2.49 (1.85 - 3.35)	1.66 (0.96 – 2.85)		
	Strongly Disagree			2.29 (1.49 – 3.50)	1.89 (0.78 – 4.62)		

Model 1: Adjusted for 2-Parent Household and Demographic Variables, Model 2: Adjusted for Academic Factors, Model 3: Adjusted for Psychosocial Factors, Model 4: Adjusted for Psychosocial and Academic Factors, Model 5: Adjusted for Neighborhood/ School Factors, Model 6: Added Percent Truancy

[1] OR: Odds Ratio [2] CI: Confidence Interval, (ref): Reference Group

Figure 1: Analytic Sample (Onset)

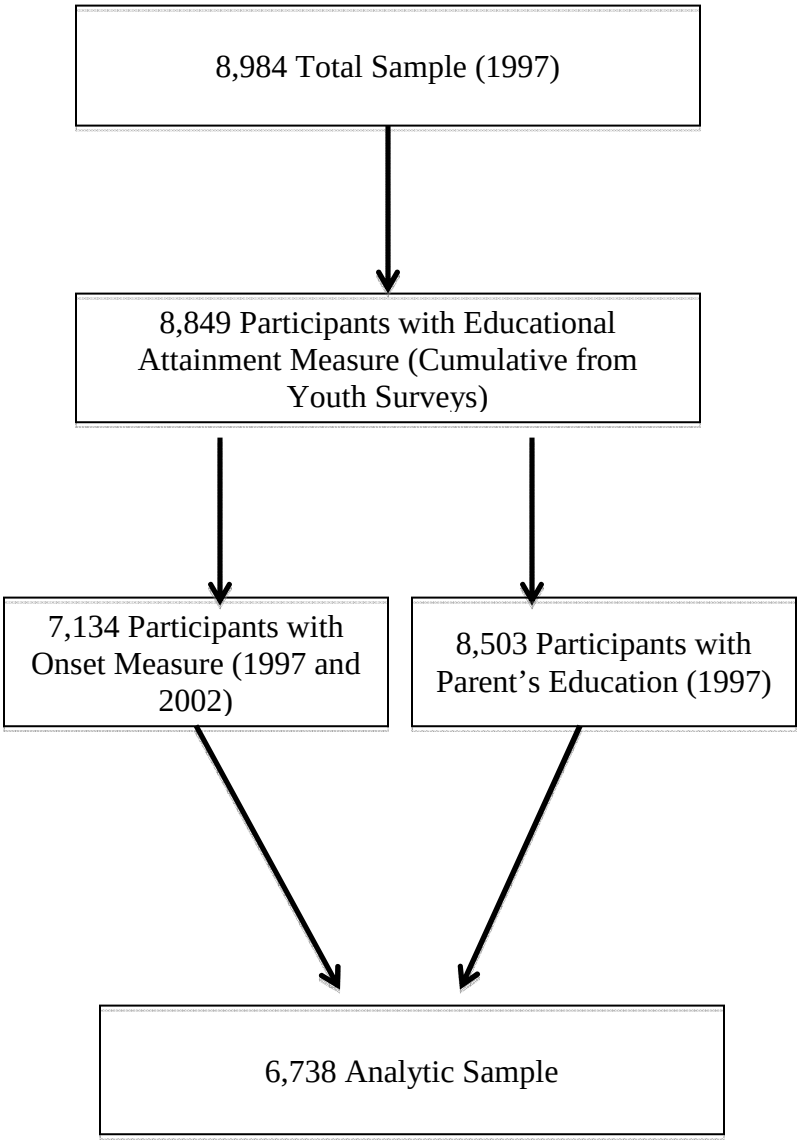
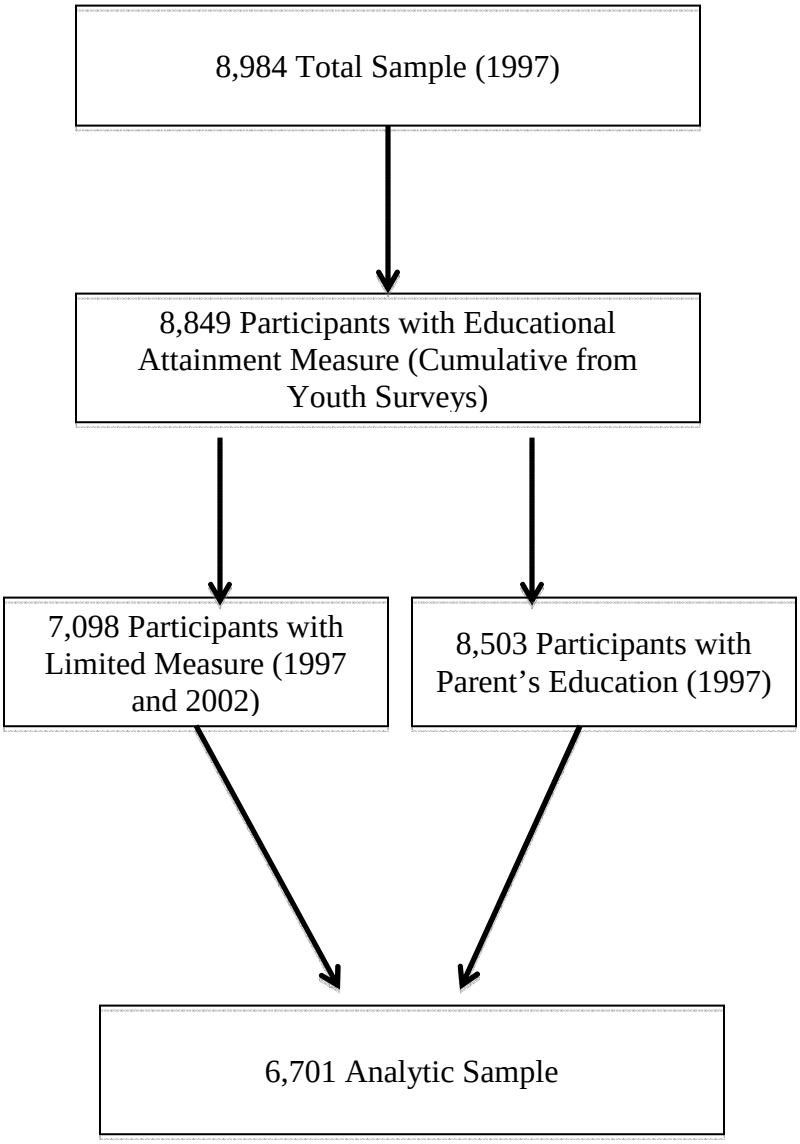


Figure 2: Analytic Sample (Limited)



Chapter 5: Manuscript 3

The Association of Chronic Health Conditions and Poor Educational Attainment: Potential Effect Modification by the Family, School and Neighborhood

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Manuscript type: Original Research

Key Words: chronic health conditions, educational attainment, social ecological approach, family, school, neighborhood

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Abstract

Background: Youth with chronic health conditions are at risk of lower educational attainment compared to youth without chronic health conditions. Contextual factors, such as those of family structure, neighborhood, or school may alter this association. We evaluated whether the family, school or neighborhood modified the association with chronic health conditions and poor educational attainment.

Methods: The National Longitudinal Survey of Youth – Cohort 1997 was used for this study. Chronic health conditions were identified from surveys in either 1997 or 2002. Poor educational attainment was defined as not completing a high school diploma or Graduate Equivalency Degree (GED) by 21 years of age. Regression models with interaction terms and subsequent stratification were used to determine the level of modification of the contextual factors.

Results: Twenty two percent of the sample reported having a chronic health condition. Among youth who attended a school with higher truancy, the odds of poor educational attainment were higher for those participants who had a chronic health condition compared to participants who never had a chronic health condition, OR: 1.93 (95% CI: 1.28 – 2.92). There were similar results for those with a 2-parent household, OR: 1.93 (95% CI: 1.28 – 2.92). These associations were not significant for participants without a 2-parent household and participants that attended a school with a lower truancy.

Conclusions: The percentage truancy at the school and a 2-parent household modified the association for youth with chronic health conditions and poor educational attainment.

INTRODUCTION

An estimated 32 million children in the United States are afflicted by a chronic health condition [1, 2]. Recent longitudinal studies in the United States, including our past work, have determined an association between youth with chronic health conditions and poor educational attainment, such that the prevalence of not completing high school or obtaining a Graduate Equivalency Degree (GED) ranges from 16% to 20% [3-6]. This prevalence is greater than the 10% to 12% prevalence for those without a chronic health condition [3, 5]. Disease-specific studies from cancer survivor cohorts and childhood onset of epilepsy from Britain, Sweden, U.S, Canada and Finland have all found similar results [7-12].

The educational literature suggests that family, neighborhood and school factors influence and potentially modify a student's performance [13]. Based on this information, we implemented a social ecological approach (Figure 1)— one that takes into account the impact on the individual from the family, neighborhood and school— to identify contextual factors that may modify the association of chronic health conditions and poor educational attainment. A student background's involves aspects of both the individual and their family. The variables that have been shown to impact educational attainment on the individual level include gender, race/ethnicity, family SES, parent's education level, and a 2-parent household. The community level encompasses both the school and neighborhood. School variables include school type, teacher experience and student composition. Neighborhood variables include student's peers in the neighborhood and neighborhood resources. In Figure 1 we display our model that places each factor that potentially impacts an individual's educational attainment on the

individual or the community level. Below we explain how the social ecological model can be applied to educational attainment among those with chronic health conditions.

Individual Level: Student's Background

African Americans and Hispanics have lower educational attainment than Whites. Data from the Current Population Survey showed that Hispanics have the highest high school dropout rate (17.6% in 2009), which is considerably higher than African Americans (9.1%) or Whites (8.1%) [14]. There has been a decline in male college enrollment, which is partially attributed to a male decline in high school graduation rates. According to the Higher Education General Information Survey, 10 million females had enrolled in college compared to 7.6 million males in 2009 [15]. Female enrollment has outpaced male enrollment since the late 1970s and the gap keeps getting larger [15].

Individual Level: Student's Family Background

Family background is the best predictor of a student's successful school performance [16, 17]. More specifically, family socioeconomic status, measured as family income or parental education, has been identified as the most influential predictor for school achievement [13]. A study showed that children who experienced poverty before attending school had worse educational outcomes compared to children who experienced poverty while attending school [18]. Other work has indicated that youth with single parent or step-families have significantly higher rates of high school dropout compared to those from 2-parent households [19, 20].

Community Level: School

A student's educational achievement and attainment are affected by school factors. Resnick et al found that a feeling of connection to family and school was

protective against many poor risk health behaviors among seventh to twelfth graders [21]. A meta-analysis conducted by McLaughlin and Drori identified 19 studies that found that a caring school climate was associated with higher grades, engagement, attendance, expectations and aspirations, a sense of scholastic competence, fewer school suspensions and on time progression through grades [22]. Negative aspects associated with the school climate have been examined and shown to have detrimental results to academic achievement. Teacher and student tardiness, lack of academic challenge, vandalism, drug abuse, physical conflicts, verbal abuse of teachers, physical attacks on teachers, teacher absenteeism, student absenteeism, cutting class, apathy, robbery or theft, disrespect of teachers, alcohol abuse and weapons in school have been associated with poor student achievement [23]. Although this has not been studied previously, youth burdened with chronic health conditions may be less involved in their school and specific characteristics of the school may contribute or deter them from not completing high school.

School factors such as school type, teacher experience and student composition also affect a student's educational achievement and attainment. For instance, the quality of a school may prevent students from dropping out of high school [13, 24]. One study showed that reading scores were significantly higher in private schools compared to public schools, after adjusting for individual and school characteristics [25]. A study that utilized scores from the National Assessment of Educational Progress (NAEP) determined that students had higher NAEP scores in states with a lower teacher turnover rate [26]. Higher teacher turnover rates result in a decrease in the number of experienced teachers at the school [26]. School demographics also affect achievement [27]. In examining achievement differences, Nettles et al found that schools with different racial

compositions affected student's individual achievement scores irrespective of a student's individual race [27].

Community Level: Neighborhood

Neighborhood contexts may compound or partially alleviate the association between childhood and adolescent chronic health conditions and educational attainment. They may influence drop out rates for a number of potential reasons [13, 24, 28], including a student's peers in the neighborhood and neighborhood resources. Peers in the community who have already dropped out of school may influence the student to drop out [29, 30]. The number of and types of employment opportunities for high school dropouts in the community may also impact poor educational attainment [31]. A student with a chronic health condition may already be more removed from their educational experience and the influence of the neighborhood can contribute or deter him or her from ultimately completing high school.

Neighborhood factors may also be associated with health conditions [32]. For example, the number of fast food restaurants in the area or the amount of air pollution in the neighborhood may increase the likelihood of chronic health conditions such as diabetes and asthma. A neighborhood's education and income, health access, crime and violence may have an association with health conditions and youth development [31-35]. In a study using path analysis, researchers found that neighborhood disadvantage was associated with adolescent development, youth violence and delinquency [31, 33]. With many neighborhood factors influencing chronic health, it is important to consider how they may interact and their potential impact on educational attainment.

The objective of this study was to evaluate potential effect modification by the family, school and neighborhood in the association of chronic health conditions and educational attainment. Identification of specific factors from the school, neighborhood and family may contribute to alleviating the association of chronic health condition and poor educational attainment. These factors may help increase a student's chances of staying on a successful educational path.

METHODS

Study Sample

This study was a secondary data analysis that employed the National Longitudinal Survey of Youth – Cohort 1997 (NLSY'97), a nationally representative cohort of 8,984 youths that were 12 to 16 years old on December 31, 1996 [32]. Households were identified from 147 primary sampling units in the United States. These civilian, non-institutionalized households were screened for eligible participants. Siblings were also included in the study (n=6,819 unique households). In 1997, parental and youth interviews were administered and the youth continued to be interviewed on an annual basis through 2009 (13 rounds available). Additional information was obtained from special access files at the Bureau of Labor Statistics including a geocoded census tract location file and school surveys.

Exposure – The parent survey in 1997 included a question about if the participant ever had a chronic health condition. The participant in 2002 was asked if he or she were ever diagnosed with a chronic health condition. Both the participant and parent were asked to identify the type of chronic health condition. Responses in the 1997 parent survey included asthma, heart condition, anemia, diabetes, cancer, epilepsy, and other

(specify). Infectious diseases, Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS), kidney, allergies, other sexually transmitted diseases or other were included in "Other." Responses in the 2002 youth survey included asthma, cardiovascular or heart condition, anemia, diabetes, cancer, epilepsy, HIV/AIDS, Sexually transmitted disease other than HIV/AIDS and other (specify).

If the parent or participant did not report a chronic health condition during these times, the participant was classified as "Never had a chronic health condition." The reported presence or absence of a chronic health condition was used to determine family, school and neighborhood interactions.

A consensus definition of childhood chronic health conditions was developed for large, epidemiological studies [36]. The criteria were based on the following factors or conditions: 1) whether the health condition is not curable and 2) whether it has lasted longer than three months, will last longer than three months or has occurred at least three times or more during the past year and will likely recur again. Based on these guidelines, youth who reported anemia, infectious diseases, sexually transmitted diseases other than HIV/AIDS and allergies were not considered to have chronic health conditions. Using these criteria and the type of chronic health conditions reported, we categorized our chronic health measure to perform supplementary stratification analyses.

Chronic health conditions were categorized as: 1) Asthma, 2) Cancer, Diabetes or Epilepsy, 3) Heart conditions, 4) Other chronic health conditions and 5) Never had a chronic health condition. Maslow et al showed that students with asthma had better educational outcomes compared to those with non-asthmatic chronic health conditions, defined in his study as diabetes, cancer, or epilepsy [3]. Based on these findings, asthma

and diabetes, cancer or epilepsy had separate categories. Cancer, diabetes, and epilepsy were also classified together based on sample size restraints. There were other chronic health conditions available in our dataset that we wanted to explore. Among the other chronic health conditions reported, heart or cardiovascular conditions had the largest sample size. Consequently, "Heart conditions" was a separate category. The other chronic health conditions were added together due to size constraints.

Outcome – Educational attainment was operationalized by whether the participant completed a high school diploma or obtained a GED by 21 years of age. The participant was asked when or if they had graduated high school or obtained a GED during each survey period.

Potential Confounders and Effect Modifiers – A series of variables were first assessed from the student's background as well as neighborhood and school levels. The hypothesized interactions were chosen from the student's background, neighborhood and school level.

Individual Level: Student's Background

The following individual level variables from the student's background were adjusted for in the analysis: 1) age of the participant, 2) gender of the participant, 3) race/ethnicity of the participant. Each of these variables was collected in the baseline year (1997). These variables were considered confounders for this association based on previous literature and past work [3, 5]. Categories for race/ethnicity included 1) Black – Non-Hispanic, 2) Hispanic 3) Mixed Race – Non-Hispanic and 4) Non-Hispanic and Non-Black. Survey staff designed this variable, which integrated the 1997 race and ethnicity survey questions, household population oversampling information and biological parent's

race/ethnicity. This method allowed each participant to be classified into one of these categories. Those in the Non-Hispanic and Non-Black category were mostly White but also included every other racial/ethnic category that was neither Hispanic nor Black (94% White). There were very few participants classified as Mixed Race – Non-Hispanic (1% of the sample). This category was subsequently added to the Black – Non-Hispanic category.

Individual Level: Student's Family Background

Parent's education was assessed by the highest grade that either biological parent completed regardless of if the participant lived with that parent in 1997. This variable was assessed continuously on a 0 to 20 scale ranging from none (0) to eight years of college or more (20). A 2-parent household was assessed by whether the participant had both biological parents in the home in 1997. Each of these variables was collected in the baseline year (1997). Interactions with chronic health conditions were evaluated.

Community Level: Neighborhood

Neighborhood socioeconomic status was obtained from data stored at the Bureau of Labor Statistics in Washington, DC. This dataset provided census tract information from the participant's residence in 1997. Census 2000 information was merged to the participant's residential information using SAS. The median household income in 1999 was used to define the participant's neighborhood income.

Community Level: School

The National Opinion Research Center (NORC) developed school surveys that were sent to the principal of all schools that had a 12^{th} grade within the 147 National Longitudinal Survey of Youth - 1997 primary sampling units in 1996. The eligible schools were

obtained from a commercial database. All schools attended by the participant were sent follow-up surveys in 2000. When one variable from the school was missing from 1996, the 2000 survey was used. The term 'school' was operationalized as the school attended by the participant in 1997. If all information for the school was missing, the next school the student attended was used. The following variables were used in our models: (1) 5-year teacher turnover, (2) percentage of Non-Hispanic White students and (3) percentage truancy. 5- year teacher turnover was calculated by the number of teachers who taught five years ago divided by the total number of teachers at the school. The percentage of Non-Hispanic White students was used to determine the racial and ethnic composition of the participant's school. The percentage truancy at the school assessed the school environment.

Analysis

Descriptive statistics of the sample's family, school and neighborhood were compared across participants' educational attainment and chronic health condition status by bivariate analyses using chi-square and t-tests. Multivariate logistic regression was used to examine the association between chronic health conditions and not completing high school or a GED by 21 years of age while controlling for confounders. Interaction was examined by the addition of terms in the model.

We evaluated a series of factors from the family, school and neighborhood as well as interactions with a backwards elimination. This method to determine interactions is outlined by Jaccard and Turrisi [37]. Based on interaction terms identified, stratified analyses were conducted. For continuous variables, higher or lower group levels were created based on the sample mean and distribution in order to conduct stratification. The

mean was used to give each modification category a similar sample size. Lower truancy was considered those schools that reported truancy equal to or below the mean (less than or equal to 3.93%). Higher truancy was assessed as above the mean reported percentage. The final models had odds ratios for chronic health conditions and educational attainment based on each modification level. We only used complete cases for each analysis. The sample started with 8,984 participants and was reduced by to 8,849 by the participants who did not have an educational attainment measure. The number of participants who did not have a chronic health measure or a parent's education value trimmed the number to n= 6,795. When school and neighborhood factors were added the final analytic sample was n=3,516 (Figure 2). There were many missing values for the school (n=3760). Based on the exposure and confounders, it was shown that missing values from the school were similar to the analytic sample. However, the missing values for the age of the participant, race/ethnicity composition and parent's education level were statistically significantly different. The analytic sample was older by close to 14 months, 3.6 percent more Non-Hispanic, Non-Black and the youth's parents had completed half a grade more compared to missing school and neighborhood participants. A stratified analysis with categorized chronic health conditions was also conducted. Using proc surveylogistic in SAS 9.1 (SAS Institute, Cary, NC), many models were fit for the association of chronic health conditions and poor educational attainment. We controlled for the complex survey design of the NLSY'97 by incorporating primary sampling units, strata and customized survey weights.

RESULTS

Family, neighborhood and school sample characteristics, as well as bivariate analyses across chronic health condition status and educational attainment, are presented in Table 1. Twenty two percent of the sample reported having a chronic health condition and eighty five percent reported completing a high school diploma or GED by 21 years of age. Among youth who did not complete a GED or high school diploma by age 21, fifty five percent were male (data not shown).

As shown in Table 1, the average neighborhood median income for youth who received a high school degree or GED was $46,022 and the average neighborhood median income for youth who did not receive a high school degree or GED was $39,178 (t-test: $p<0.01$). The mean reported percentage truancy in schools was 4%. Among students who did not complete a high school diploma or a GED by 21 years old, the mean percentage school truancy was 5%. For youth who reported a chronic health condition, the school mean percentage truancy was 4.5%. Among participants who did not report a chronic health condition, 46% did not live in a 2-parent household. Among youth who had a chronic health condition, 50% did not live in a 2-parent household.

Two effect modifiers were identified with chronic health conditions: percentage truancy ($p=0.04$) and 2-parent household ($p<0.01$). Stratified analyses of percentage truancy are presented in Table 2 and stratified analyses of a 2-parent household are shown in Table 3.

Among participants who attended schools with a higher truancy, youth who had a chronic health condition had higher odds of poor educational attainment, OR: 1.93 (95% CI: 1.28 – 2.92) compared to youth who did not report a chronic health condition (Table

2). Among participants who attended a school with a lower truancy, the odds of poor educational attainment was not significantly different for youth who had a chronic health condition compared to youth who did not report a chronic health condition, OR: 1.11 (95% CI: 0.76 – 1.63) (Table 2). This association was specific for youth with asthma, 1.95 (1.21 – 3.16) and nearly for cancer, diabetes, or epilepsy, 3.57 (OR: 95% CI: 0.98 – 13.05) compared to youth that did not report a chronic condition (Table 2).

We stratified by whether the participant had a 2-parent household (Table 3). Among participants with a 2-parent household, youth who reported having a chronic health condition had higher odds of poor educational attainment compared to youth who never reported a chronic health condition, OR: 2.86 (95% CI: 1.83 – 4.48). If the family was not a 2-parent household, the association between chronic health conditions and poor educational attainment was not significant, OR: 1.05 (95% CI: 0.77 - 1.44). We also conducted a siblings fixed effect model (not reported) and the stratified odds ratios were similar to those reported. Siblings fixed effect models effectively remove within-family variation and only display between-family variation in the analysis models.

DISCUSSION

Overall, two effect modifiers were found for the association of chronic health conditions and educational attainment: the percentage truancy in the school, and a 2-parent household. Neighborhood level variables were not effect modifiers.

After stratification, only youth who reported a chronic health condition and attended a school with higher truancy had significantly higher odds of poor educational attainment. These associations were robust for cancer, diabetes, or epilepsy and youth with asthma. According to our social ecological model, these findings demonstrate that

the school is influential for a person with chronic health conditions' educational attainment adjusting for confounders.

Rumberger developed a framework for studying a student's performance. He suggested that students who drop out of high school are involved in a cumulative disengagement process [13]. His framework concludes that the school, neighborhood and family factors affect a student's school engagement, and engagement is critical for achievement and educational attainment [13]. There is evidence that certain school policies and processes may lead to poor school engagement and contribute to voluntary withdrawal from school [13], although this has not previously been studied among youth with chronic health conditions. Schools with lower truancy may have more effective school policies and processes that indirectly alleviate stressors associated with chronic health conditions that otherwise contribute to poor school engagement and lead to withdrawal from school. Although we controlled for family and individual variables in our models, youth who attended these different schools likely have different families and individual characteristics that may still affect this association. We adjusted for socioeconomic status from the individual and the school at baseline. However, the cumulative effect of poverty is important to our study's results. For example, the school the participant attends is partially due to both past and present financial considerations. These results may also be a reflection of peer influences at the school. If fellow students are already less engaged in the school it might be easier for the youth burdened by a chronic health condition to become less engaged and withdraw from school.

School policies such as intensive academic recovery options and emotional support services which might exist in schools merit further study. Examination of other

specific policies such as homebound instruction and how these practices maintain a student's academic standing could be important as well. Overall, future studies that examine a child's health and their attainment may consider effect modification by the school environment.

Percentage truancy was also associated with type of school attended; public schools had higher truancy compared to private schools (not reported). This may reflect an inequality in school resources. These resources may include school programs, opportunities and support that may help modify the association. A more rigorous academic environment with fewer general track and remedial courses has been shown to lead to fewer dropouts and a higher number of students completing high school [12]. It should be noted that school ACT/SAT scores and class size were not significant predictors of an individual's poor educational attainment and were not included in our final model (not reported).

The 2-parent household was also identified as an effect modifier. The odds of those with chronic health conditions and poor educational attainment were significantly elevated only among youth with a 2-parent household. These results were not expected. We examined the youth who did not report a chronic health condition and among these participants those without a 2-parent household had more than twice the non-completion rate compared to those who had a 2-parent household. This large difference in the comparison groups' graduation rates may be largely responsible for the interaction seen with chronic health conditions.

In our prior work, students with a 2-parent household had significantly more educated parents, higher high school grade point averages, higher cognitive scores, fewer

depressive symptoms, and fewer school absences than youth students that did not have a 2-parent household [5]. Past work has shown each of these academic and psychosocial factors are important attenuators for the association of chronic health conditions and poor educational attainment [5, 38]. In the introduction we suggested that poverty and socioeconomic status were very important for academic performance. There may be significant differences in terms of early childhood and cumulative poverty between youth with a 2-parent household compared to youth without a 2-parent household. These differences could create a large disparity for academic achievement as well as educational attainment.

Neighborhood level factors did not significantly modify the association with chronic health conditions and poor educational attainment. Crane concluded there may be a tipping point in the neighborhood that yields higher dropout rates [28]. In his contagion model when a critical point in incidence is reached, the social behavior spreads like an epidemic. For instance, gang violence will spread and increase to a much higher incidence level when a critical threshold in the neighborhood is reached. Although research has been mixed regarding a neighborhood tipping point, future studies may examine this and the effects on the association of chronic health conditions and poor educational attainment.

Limitations of the study included that self-reported, parent-reported and principal-reported surveys are subject to measurement error. We assessed chronic health conditions by using both the 1997 parent questionnaire and 2002 youth questionnaire. These asked slightly different questions. The survey in 1997 asked the parent if the participant ever had a chronic health condition and the 2002 survey asked if a condition

was ever diagnosed. A self-reported diagnosis requires the participant to see a physician. Health access may be limited for more disadvantaged participants. Consequently, this question may not accurately capture everybody with these chronic health conditions. A doctor's diagnosis may be based on different criteria and misdiagnosis is possible as well. For example, doctors may choose not to diagnose a patient with asthma because of the stigma associated with the condition. There were respondents that specified other chronic health conditions that were not directly asked about in either the 1997 or 2002 survey (e.g. infectious diseases, Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS), kidney, allergies, other sexually transmitted diseases). We do not know whether we have captured everyone with these specific conditions.

Another limitation was our sample size for evaluating effect modification. The school surveys had many missing values. This restricted our ability to test for interactions and affected the ensuing stratification. Participants started the cohort at many different grades, which may have affected school level results. In our disease specific analysis, cancer, diabetes, or epilepsy needed to be grouped together similar to the work of Maslow et al because of sample size constraints [3]. This study lacked a severity measure for the chronic health conditions reported. This may affect the associations identified. Strengths of the study included that this is a nationally representative cohort with many school, and neighborhood measures. Moreover, we utilized a dataset with a unique combination of health and education variables that allowed this association to be examined.

Chronic health conditions affect students who strive for academic success. This study determined interactions that demonstrate that contextual factors are important when a student is afflicted by a chronic health condition. These factors can make youth with a chronic health condition more likely to thrive. The neighborhood appears to be less important than the school environment in terms of its influence on the relationship of chronic health conditions and educational attainment. Chronic health conditions are on the rise and understanding these contextual factors better help efforts to modify their poor educational outcomes.

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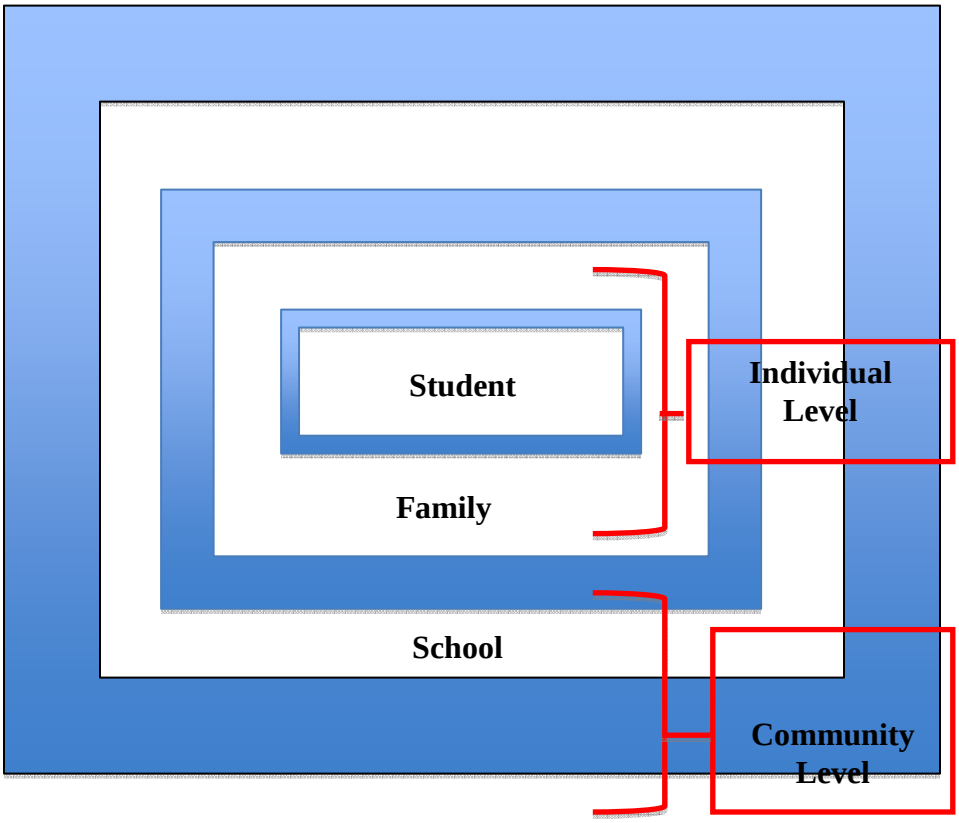
Figure 1: Social Ecological Model: Factors Involved In Study



Individual – Student's Background: Gender, Race/Ethnicity, Age
Individual – Student's Background: Parent's Education, 2-parent Household
Community – School: 5-Year Teacher Turnover, Percentage of Non-Hispanic White Students, Percentage Truancy
Community – Neighborhood: Neighborhood Income

Figure 2: Analytic Sample

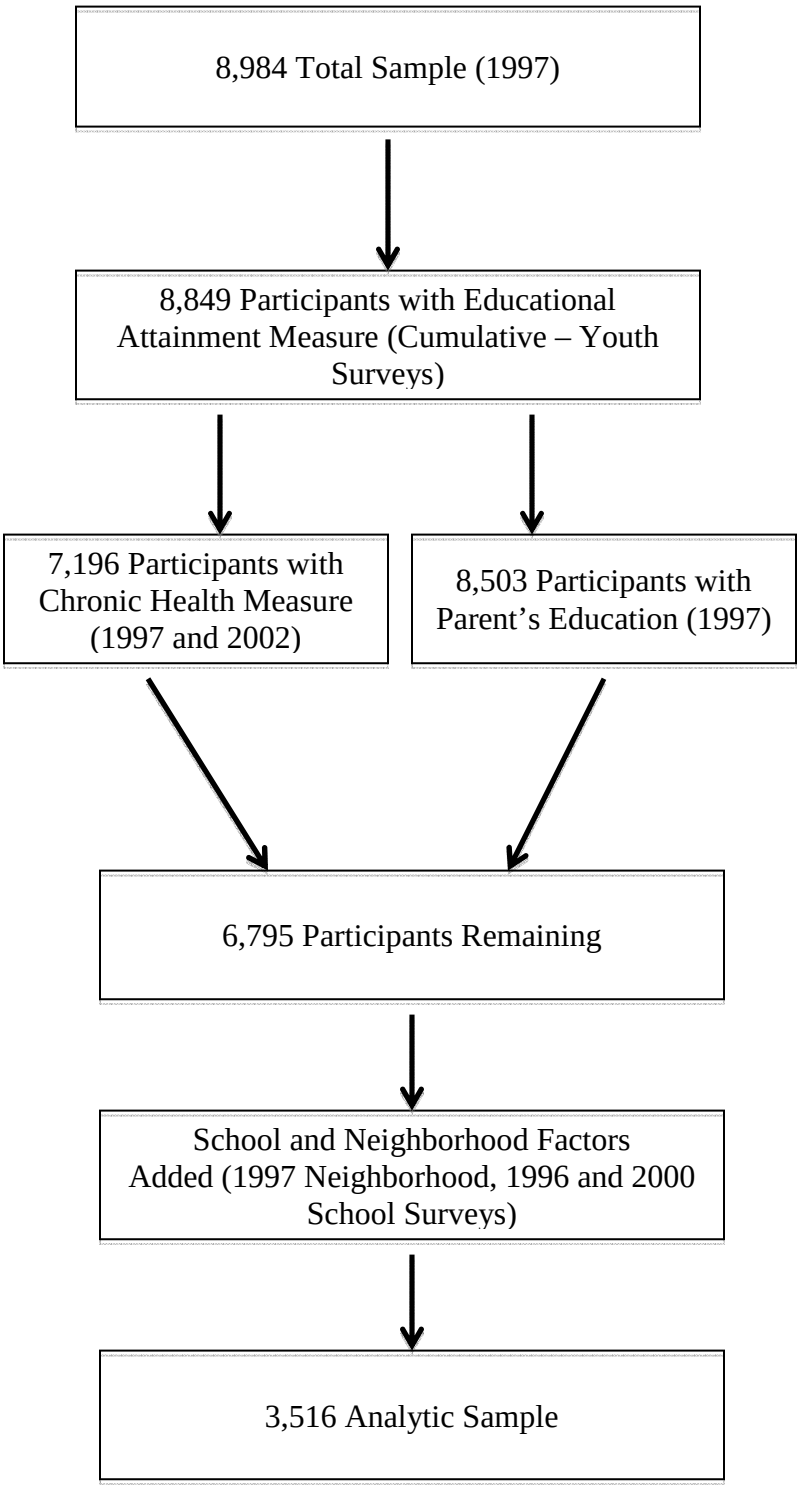


Table 1: School and Neighborhood Characteristics Of The National Longitudinal Survey Of Youth By Graduation Rate and Chronic Health Condition

	Overall n=8984 %[1] /Mean (SE[2])	**Completed A HSD[3] Or GED[4] n=7286**	**No HSD Or GED n=1563**	**p-value**	**No Chronic Condition n=5638**	**Ever had a Chronic Condition n=1558**	**p-value**
Total	100	84.55%	15.45%	[7]p<0.01	77.83%	22.17%	[7]p<0.01
Census Tract Neighborhood							
Income (n=8959)	$44,894 ($1.287)	$46,022 ($1,386)	$39,178 ($845)	[8]p<0.01	$44,608 ($1,208)	$44,956 ($1,609)	[8]p=0.64
School							
%[1] of NH[6] Whites (n=5224)	70.05% (2.31%)	71.45% (2.45%)	60.13% (2.04%)	[8]p<0.01	70.73% (2.23%)	71.29% (2.54%)	[8]p=0.56
5-year Teacher Turnover (n= 5106)	83.10% (0.59%)	83.35% (0.60%)	81.25% (0.91%)	[8]p=0.01	83.01% (0.67%)	83.57% (0.90%)	[8]p=0.44
%[1] Truancy (n=4847)	3.96% (0.30%)	3.78% (0.33%)	4.98% (0.33%)	[8]p=0.01	3.83% (0.26%)	4.51% (0.78%)	[8]p=0.04
Family							
Parent's Education (n=8984)	13.58 (0.09)	13.88 (0.09)	12.00 (0.10)	[8]p<0.01	13.70 (0.09)	13.73 (0.12)	[8]p=0.80
2-Parent Household (n=8984)							
Yes	52.94% (1.06)	56.65% (1.05)	34.55% (1.57)	[7]p<0.01	54.38% (1.08)	50.21% (1.80)	[7]p<0.01
No	47.06% (1.06)	43.35% (1.05)	65.45% (1.57)		45.62% (1.08)	49.79% (1.80)	

[1] %: Percentage [2] SE: Standard Error [3] HSD: High School Diploma [4] GED: Graduate Equivalency Degree [5] n: Observations [6] NH: Non-Hispanic
[7] χ^2: chi-square test [8] t: t-test

Table 2: Stratification of Truancy for Ever Having a Chronic Health Condition and Chronic Health Condition Categories Adjusting for Demographic, School and Neighborhood Variables*

Lower Truancy (Less Than or equal to 3.93%) OR[1] (95% CI)[2] n=2244			**Higher Truancy (Greater Than 3.93%)** OR[1] (95% CI)[2] n=1272		
Chronic Health Condition	Ever Had A Chronic Health Condition	1.11 (0.76 – 1.63)	Chronic Health Condition	Ever Had A Chronic Health Condition	**1.93 (1.28 – 2.92)**
	Never Reported A Chronic Health Condition	(ref)		Never Reported A Chronic Health Condition	(ref)
Chronic Health Condition	Asthma	1.20 (0.74 – 1.94)	Chronic Health Condition	Asthma	**1.95 (1.21 – 3.16)**
	Cancer, Diabetes, Epilepsy	2.69 (0.96– 7.54)		Cancer, Diabetes, Epilepsy	3.57 (0.98 – 13.05)
	Heart Condition	0.24 (0.03 – 1.67)		Heart Condition	1.16 (0.30 – 4.46)
	Other	1.99 (0.65 – 6.06)		Other	0.60 (0.10 – 3.50)
	Never Reported A Chronic Health Condition	(ref)		Never Reported A Chronic Health Condition	(ref)

*Adjusting For Parent's Education, Race/Ethnicity, Gender, Age, 2-Parent Household, Percentage of Non-Hispanic Whites, 5-Year Teacher Turnover, and Neighborhood Income

[1] OR: Odds Ratio of Poor Educational Attainment [2] CI: Confidence Interval, (ref): Reference Group

Table 3: Stratification of 2-Parent Household for Ever Having a Chronic Health Condition and Chronic Health Condition Categories Adjusting for Demographic, Neighborhood and School Variables*

Not a 2-Parent Household OR[1] (95% CI)[2] n=Observations n=1720			**2-Parent Household** OR[1] (95% CI)[2] n=Observations n=1796		
Chronic Health Condition	Ever Had A Chronic Health Condition	1.04 (0.77 – 1.42)	Chronic Health Condition	Ever Had A Chronic Health Condition	**2.86 (1.83 – 4.46)**
	Never Reported A Chronic Health Condition	(ref)		Never Reported A Chronic Health Condition	(ref)
Chronic Health Condition	Asthma	1.16 (0.77 – 1.75)	Chronic Health Condition	Asthma	**2.57 (1.50 – 4.41)**
	Cancer, Diabetes, Epilepsy	**2.64 (1.01 – 6.93)**		Cancer, Diabetes, Epilepsy	**4.61 (1.20 – 17.80)**
	Heart Conditions	0.43 (0.09 – 1.93)		Heart Conditions	1.29 (0.15 – 11.09)
	Other	0.68 (0.21 – 2.14)		Other	**4.11 (1.32 – 12.76)**
	Never Reported A Chronic Health Condition	(ref)		Never Reported A Chronic Health Condition	(ref)

*Adjusting For Parent's Education, Race/Ethnicity, Gender, Age, Percentage of Non-Hispanic Whites At the School, 5-Year Teacher Turnover, Percentage Truancy and Neighborhood Income

[1] OR: Odds Ratio of Poor Educational Attainment [2] CI: Confidence Interval, (ref): Reference Group

Chapter 6: Conclusions

6.1 Key Findings and Discussion

There was an association between youth that ever reported a chronic health condition and poor educational attainment. Youth who ever reported having cancer, diabetes and epilepsy had the highest odds of poor secondary school completion compared to youth who did not report a chronic health condition. Youth with asthma also had elevated odds of poor high school completion compared to youth who did not report a chronic health condition. These findings were consistent with previous literature in the US.[8,20] Youth with heart or cardiovascular conditions had no significant association with poor educational attainment compared to youth without chronic health conditions.

Onset of and Those Limited by Chronic Health Conditions

When the association of chronic health conditions and educational attainment was established, we then examined potentially high-risk groups that involved youth limited by a chronic health condition, early onset of a chronic health condition and youth limited and had early onset of chronic health conditions. Youth with early onset of chronic health conditions, youth limited by chronic health conditions and youth limited and had early onset of chronic health conditions all had associations with poor educational attainment. Each group had significantly higher odds of poor secondary school completion compared to those that did not report a chronic health condition (OR: 1.70 (95% CI: 1.27 - 2.28), OR: 1.61 (95% CI: 1.28 - 2.01) and OR: 1.74 (95%: 1.24 - 2.43), respectively). Each group also had higher overall odds ratios compared to ever reporting

a chronic health condition (OR: 1.70, OR: 1.61, OR: 1.74 vs. OR: 1.47 (95% CI: 1.22 - 1.76)).

Youth who reported early onset of their chronic health condition (12 years or younger) had higher odds of poor educational attainment compared to youth who reported not having a chronic health condition. We also found that youth with later onset of their chronic health condition (13 and older) had higher odds of poor educational attainment compared to youth who report not having a chronic health condition, OR 1.42 (95% CI: 1.00 – 2.02). However this association was no longer significant when the 2-parent household variable was added, OR: 1.35 (95% CI: 0.94 - 1.94). Early onset of a chronic health condition had higher odds ratios compared to youth with later onset of a chronic health condition (OR: 1.61 vs. OR: 1.35).

These findings were consistent with previous studies. A study by Maslow in 2012 recently found youth with younger onset of chronic health conditions (less then 18 years of age) had worse educational outcomes then youth who had adult onset (18 and older).[20] Our study used a younger adolescent population compared to Maslow's study that used a sample of 18 to 28 year olds.[20] Those with asthma were excluded from their study whereas our study included participants with asthma.[20] Overall, our findings were similar to previous literature but it also identified youth that have early onset (12 years or younger) of a chronic health condition as a high-risk group that are critical for prior associations with chronic health conditions and poor educational attainment identified in the literature.

Youth who reported that they were currently limited by their chronic health condition had higher odds of poor educational attainment compared to youth who

reported not having a chronic health condition. Compared to youth with early onset of a chronic health conditions, those youth limited by their condition had the higher odds ratios or poor educational attainment. This suggests that youth that are currently limited by a chronic health condition is the best chronic health measure for poor educational attainment. Among individuals who were limited by a chronic health condition, 74% were youth that reported ever having asthma. As previously discussed in paper 2, mild conditions such as mild asthma may obscure the effect on poor educational outcomes. Our findings suggest that youth limited by asthma was an important parameter to implement when identifying those at risk for poor educational attainment. Some studies do not include asthma entirely. Those currently limited by asthma may be the best inclusion criteria for studies.

Effects of Academic and Psychosocial Factors

Academic and psychosocial variables reduced the association between chronic health conditions and poor educational attainment. This was related to Haas' findings that showed the association of self-reported health and educational attainment was attenuated by academic and psychosocial factors.[27] More specifically, our study showed that academic variables significantly reduced the association for youth with cancer, diabetes or epilepsy and poor educational attainment but not for asthma. It was unexpected that youth that reported asthma were seemingly unaffected by these variables. Of all the psychosocial variables, depressive symptoms reduced the association with poor educational attainment the most for both youth with asthma and for youth with cancer, diabetes and epilepsy. It appears there is a cascade of events that occur when a

participant has a chronic health condition that sends them on the path to poor educational attainment.

It was shown that academic and psychosocial variables attenuated the associations of youth limited by a chronic health condition as well as early onset of a chronic health condition and poor educational attainment. These high-risk groups may benefit from prevention strategies involving academic and psychosocial factors if feasible. Different academic factors distinctly influenced each measure's association with poor educational attainment. For example, youth participants that repeated a grade did not attenuate the association with early onset of the chronic health condition and poor educational attainment. Grade point average and other academic variables however did significantly reduce this association. This contrasted with youth limited by a chronic health condition where the variable repeated a grade was the only academic variable that attenuated the association with those youth limited by a chronic health condition and poor educational attainment. Our results suggest that youth with early onset of chronic health conditions were more influenced by grade point average compared to grade repetition while youth limited by a chronic health condition was more influenced by grade repetition compared to grade point average.

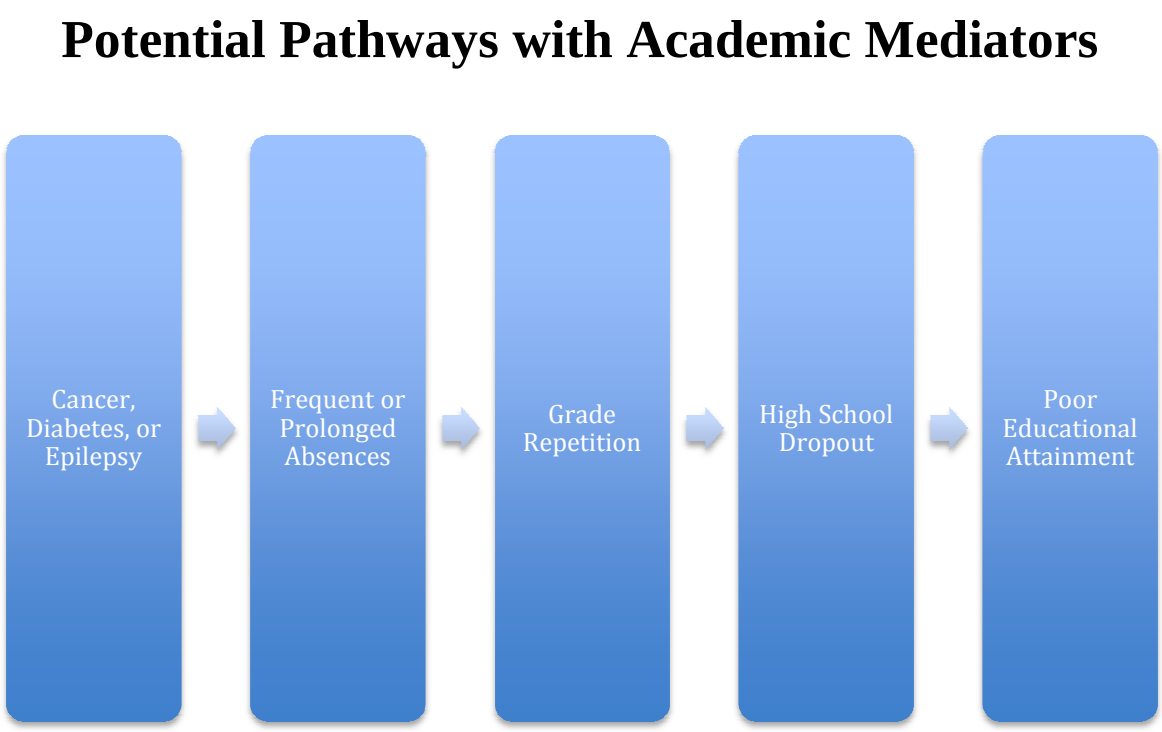
Mediation Analysis

Mediation analyses on the association of specific chronic health conditions and poor educational attainment revealed that the variables, repeated a grade, school absences as well as depressive symptoms were separately considered full mediators for youth who ever had cancer, diabetes or epilepsy and poor educational attainment. These findings may help parents and teachers that have children with cancer, diabetes or epilepsy

become aware of the factors that lead to poor educational attainment. If feasible, an academic plan designed to avoid grade repetition and high number of absences from school may be important.

Literature shows that grade retention and absences from schools are correlated.[85,86] Students that have many absences from school are more likely to repeat a grade.[85] Those students that repeat a grade are more likely to drop out of high school.[86] This identifies a potential pathway to poor educational attainment for students with cancer, diabetes, or epilepsy. Youth with these chronic conditions are more likely to have frequent or prolonged absences and this may lead to grade repetition, which ultimately leads to dropping out of high school and overall poor educational attainment.

Figure 5: Potential Pathways with Academic Mediators



Depressive symptoms score mediated the relationship for youth who ever had cancer, diabetes or epilepsy. For youth who had asthma, the addition of the variable depressive symptoms score also reduced the association with poor educational attainment. This suggests that parents of youth with cancer, diabetes, epilepsy or asthma should be aware of depression complications, and potentially collaborate with their teachers and school to assure more immediate factors are alleviated which can foster a more positive environment (not bullied, feeling safer at school) and promote a better quality of life.

These results suggested that depressive symptoms score were a very important psychosocial factor involved in a participant's chronic health condition. It has been suggested that depression and depressive symptoms are a major complication of chronic health conditions.[87,88,89] A potential mechanism for students with cancer, diabetes, or epilepsy can be seen where the academic factors (absenteeism or grade repetition) from the chronic health conditions may lead to a higher depressive symptoms score and then affect poor educational attainment. Depressive symptoms score becomes critical because it may not be possible to keep the youth afflicted with these chronic health conditions from missing school or repeating a grade. As we have concluded in paper 1, treatment of depressive symptoms for youth with chronic health conditions must be a clinical priority and physicians need to be aware of the risk of poor educational attainment for youth with chronic health conditions.

School and Neighborhood Factors

School and neighborhood variables did not affect the association with chronic health conditions and educational attainment. However, school-level factors, particularly

school characteristics, appeared to be important in the association of early onset of a chronic health condition (12 years and younger) and educational attainment. This suggests that parents with an early onset of chronic health conditions might consider the characteristics of the school to potentially improve the educational outcomes for their child with chronic health conditions. However, further research needs to be conducted on specific programs and policies such as homebound instruction, academic credit recovery and counseling services. Other aspects such as health management programs may also be critical for students. School nurses may help students with chronic health conditions better manage their conditions and allow them to stay more focused and engaged in achieving educational goals and is a prospective future direction of research.[90] There is a Healthy Person 2020 objective to increase the number of school nurses in schools by a proportion of 750 students to 1 nurse.[90] The American Academy of Pediatrics recommends that parents meet with the child's school and develop a plan to address their needs.[91]

The neighborhood factors on the county or census tract level did not affect any of the associations with chronic health conditions and educational attainment. The school, family and individual appeared to be more important compared to the neighborhood. However this needs to be further studied. The neighborhood may not properly be represented. The neighborhood defined on the census block level or participants' own interpretation of the neighborhood parameters may better characterize the neighborhood. Participants may have relocated since 1997.

Effect Modification

When testing for effect modification of family, neighborhood and school factors, two effect modifiers were found: percentage truancy at the school ($p=0.04$), and a 2-parent household ($p<0.01$). Among participants that attended a school with higher truancy, those youth that reported a chronic health condition had significantly higher odds of poor educational attainment compared to youth that did not report a chronic health condition. Among participants that attended a school with lower truancy, youth that had chronic health conditions did not have significantly higher odds of poor educational attainment compared to youth that did not ever report a chronic health condition. This may suggest that schools with lower truancy have more effective policies that indirectly alleviate stressors associated with chronic health conditions.

Applying Rumberger's cumulative disengagement framework, these stressors may otherwise lead to disengagement and withdrawal from school. Our results suggest that a student with a chronic health condition's educational attainment may be influenced by peer engagement in school. Peers who are less engaged in school may influence a youth afflicted with a chronic health condition to withdraw from school. Specific programs and policies need to further studied.

We also found that there was effect modification with the 2-parent household and those that ever had a chronic health condition. Among participants that lived in a 2-parent household, youth that reported a chronic health condition had significantly higher odds of poor educational attainment compared to those that never reported a chronic health condition. Among participants that did not live in a 2-parent household, youth that reported a chronic health condition did not have significantly higher odds of poor

educational attainment compared to those that never reported a chronic health condition. As concluded in paper 3, these results were not expected. In prior analysis, we have showed that the 2-parent household was protective against poor educational attainment outcomes. This effect modification may be a reflection of the disparate comparison groups among the different strata.

Poverty Context

This study implemented the variables, parent's education and race/ethnicity to control for confounding by socioeconomic status. In our school and neighborhood analyses we also adjusted for school composition by race/ethnicity and neighborhood income. These variables are generally stable over long term periods. Although we adjust for these variables at baseline in 1997, some of these youth have already been exposed to poverty and poor socioeconomic status prior to beginning the study. We presented findings in Chapter 1 from the past literature that showed children who were poor before attending school had worse educational attainment compared to children who were poor after they started attending school. We are not able to control for this early poverty in our study. Children that enter this cohort who have experienced poverty may also be more likely to have chronic health conditions from poor housing conditions, diet and environment.

These concepts are critical because they demonstrate the influences of cumulative poverty on individuals. Early life poverty and socioeconomic status is a strong predictor of poor educational attainment. In addition, this poverty may lead to chronic health conditions in adolescence. When adjusting for the youth's more current, baseline socioeconomic status, our results showed that there were elevated odds of poor

educational attainment among youth who reported a chronic health condition. Poor educational attainment is likely to lead to more poverty, health and social consequences. This can be a vicious cycle of poor health and poverty for many generations.

Understanding our results within the context of cumulative poverty is essential. It is possible that families may be more burdened financially by early onset of a chronic health condition compared to later onset of chronic health conditions. If these families are already having trouble financially, early onset of a chronic health condition could compound the poor educational attainment issues.

Treatment of chronic health conditions may be affected by financial considerations. This may lead to more limiting chronic health conditions. Early poverty combined with a chronic health condition may make it more likely to have poorly treated chronic health conditions and therefore more likely to have poor educational attainment.

In the third manuscript there may be poverty effects that are not captured in our analysis. Youth that are in a higher truancy category versus lower truancy category may have had differences in terms of cumulative poverty, which we could not control in our analysis. This is similar for the effects of having a 2-parent household versus not having a 2-parent household.

Hypothesized Variables

Overall, we found that class size was not associated with a participant's educational attainment, which was unexpected. We included this variable as a principal variable but it was not included in the final analyses. However, class size during one particular year (1997) does not capture class size for a student's entire schooling experience. We found that percentage truancy was an important variable throughout

manuscript 1, 2 and 3. Teachers with advanced degrees were added to the final analyses in manuscript 1 and 2 as well. These variables were considered tier 3 variables initially.

Neighborhood variables such as neighborhood education and neighborhood income were added in the analyses. This was consistent with our initial hypotheses where we placed both in our principal variables. The race/ethnicity of the neighborhood was hypothesized to be more important compared to the race/ethnicity of the school. However this was not the case as the race/ethnicity of the school was added in our final models and race/ethnicity of the neighborhood was not added into the final analyses.

6.2 Limitations and Strengths

This study was a secondary analysis of a nationally representative cohort. Cohort studies are subject to loss to follow up and this study had subjects who could not be followed. This study used multiple measures, which came from many different observers (parent-reported, youth-reported, principal-reported) and subject to measurement error. Our exposures and outcome measurement was based on reported measures, which is also a limitation. For example, age at onset of chronic health conditions was based on when the condition was first noticed or diagnosed which might vary substantially. Self-reported academic and psychosocial variables such as substance abuse and number of absences from school were particularly sensitive questions, which may be subject to improper reporting.

Both the 1997 parent survey and the 2002 youth survey were used to assess whether a participant had a chronic health condition, type and onset of the chronic health condition and youth limited by a chronic health condition. These surveys were different. The 1997 survey asked parents to report whether the participant ever had a chronic health

condition and the 2002 youth survey asked participants to report whether the ever had a diagnosis of chronic health conditions. These differences in the surveys were a limitation because we are obtaining slightly different participants in each survey year.

The self-reported chronic health condition measure from the parent survey has limitations. Parents that are more aware and involved in the youth's health care are more likely to respond that their child has a chronic health condition. This is also the case for parents who are more health knowledgeable.

A doctor's diagnosis of a chronic health condition requires that the participant has had medical care. Health care access is unavailable to some participants and consequently this variable may not capture every participant with a chronic health condition. This type of diagnosis may be based on different criteria and misdiagnosis is also a possibility. A physician may avoid a specific diagnosis such as asthma in order to avoid the stigma associated with the diagnosis. Ultimately, the self-reported diagnosis was subject to measurement error and therefore was a limitation. An objective medical diagnosis would have been a better measure.

Other limitations of this research included the participant's neighborhood that was defined at first the surrounding county and then the census tract. These are both large areas and may not have properly represented the participant's neighborhood. Participants also reported different types of chronic health condition that were not asked in the 1997 parent survey and 2002 youth survey. We are not sure whether we have captured all participants with these chronic health conditions. Participants started the cohort at many different grades, which may have affected school-level results. There was no examination of mental chronic health conditions. Variables in which we used the mean

to delineate categories may have different cutoff points when other datasets are implemented. We combined both completion of a high school diploma or GED in our outcome measure but each could represent unique educational pathways.

Strengths of this study included the cohort study design. The cohort design allowed for temporality where the exposure was measured before the outcome. Our study used data from the National Longitudinal Survey of Youth – Cohort 1997, which is nationally representative and has a complex survey design. This allowed us to make estimates for the entire United States population. Overall, this study had 83% retention over 13 years of data collection (2009). Subjects in our study on average were followed through Round 10 (10 years). Youth were followed while they were achieving and potentially completing a high school diploma or GED. This gave us important information for these associations as they were occurring. The study also incorporated multiple surveys with different observers (parents, youth and principal). Objective measures such as transcript information, a cognitive examination, a depression inventory and location information were also implemented in our study and allowed us to better examine key mechanisms in these associations. We also incorporated a multi-level approach (individual, family, school and neighborhood) that has never been used to examine these associations. Our theoretical framework can be extended to the framework outlined by Rumberger concerning student performance and student disengagement.

In these manuscripts, not only was the association with specific types of chronic health conditions and educational attainment examined, high-risk groups based on youth limited by a chronic health condition, age at onset of a chronic health condition and youth

limited and had early onset of a chronic health condition were also investigated. The youth's neighborhood, school, academic and psychosocial variables allowed to better understand the influences of contextual and potential mediating factors. Underlying key pathways and interactions with the association of chronic health conditions and educational attainment were assessed.

6.3 Future Directions

Future directions for this area of research may include incorporating asthma as a reference group compared to the educational attainment of other chronic health conditions in datasets that may only contain children with chronic health conditions. Performing mediation and moderation analysis on youth limited by a chronic health condition, onset of a chronic health condition and youth limited and had early onset of chronic health condition may be useful in identifying specific mediators and effect modifiers for these high-risk groups. Overall, depressive symptoms score were the most important psychosocial variable in many of these associations. Other aspects of the participant's mental health such as anxiety may be important to assess. Structural equation modeling may also be used to test our mediators and modifiers models developed. Our potential pathway that we constructed for those participants that reported cancer, diabetes or epilepsy may be tested with structural equation modeling. Examination of specific school services and policies and their influences on engagement, academic and psychosocial variables is an important next step. Depressive symptoms screenings and school support services may be potential strategies to affect these associations. We would also recommend a better proxy for school engagement. In our study, we control for the correlation of participants within each primary sampling unit but

the data came from many different levels (individual, family, neighborhood and school) and hierarchical analysis or multi-level modeling may be used to get better estimates and perhaps a better model. Identifying more specific associations that involve a combination of type of and youth limited by a chronic health condition or onset of a chronic health condition and type of a chronic health condition with poor educational attainment are also recommendations for potential future studies. In addition, a different outcome that may be implemented could be postsecondary enrollment or completion.

Overall, if this study were not a secondary data analysis, there would be other specific measures that we would have wanted to incorporate into the study. We would have preferred to review each participant's medical records to determine whether the participant ever had a chronic health condition. A severity measure to describe the chronic health conditions reported is lacking in the current study. Having access to participants' medical records as well as determining the severity of these conditions would help our study.

Our high school and GED completion outcome is also based on youth surveys. It would be better for our study if we had a dated record or certificate of completion for the high school diploma or GED received. This would avoid discrepancies in self-reported completion measures.

Additional measures that we would have introduced into our study would have involved measures from the neighborhood. We would have asked the participant to describe his or her own neighborhood boundaries. This would allow us to assess whether our current census tract level measures are representative of the participant's

neighborhood. Also, having access to the participant's census block group residence may be an improvement compared to the census tract level.

School measures that we would have added to our study include an evaluation of specific programs and policies from each school. Homebound instruction, academic credit recovery and counseling services for each school would be important to understand and would significantly add to the study. Health management service measures such as the number of school nurses or the quality of the health clinics may be improvements from the current study. These measures would have allowed us to explore in depth the results we found in our study.

Academic and psychosocial mediation was examined in our study. Many of our academic variables were excellent objective measures such as the Armed Services Vocational Aptitude Battery cognitive examination and grade point average from high school transcripts. We would not want to change these measures although we would improve on certain psychosocial variables. For example, we would like to incorporate other psychological functioning measures. Depressive symptoms score from the Mental Health Inventory – 5 was a good, quick measure for depressive symptoms. It may be useful to get a doctor's psychological evaluation. We would also like to explore different mental health aspects including a participant's anxiety.

Appendices

Appendix A: Paper 1: Variables Implemented In NLSY'97

Type	Measure	Survey and Year	Question(s)	Responses
Exposure: Chronic Health Conditions	**Ever have a Chronic Condition and Type**	**1997 Parent Survey**	**Type of Chronic Conditions**	**Asthma, Cancer, Heart Conditions, Anemia, Epilepsy, Diabetes, Infectious Disease, Kidney, Allergies and Other**
	Ever have a Chronic Condition and Type	**2002 Youth Survey**	**Type of Chronic Conditions**	**Asthma, Cancer, Heart Condition, Anemia, Epilepsy, Diabetes, HIV, Sexually Transmitted Disease, Other**
Outcome: Educational Attainment	**High School Completion**	**Youth Surveys (Cumulative)**	**When or If Obtained a GED or Completed a High School Diploma**	**Age When Completed High School or Obtained a GED – Age of Participant in 1997 (Cumulative Months)**
Potential Confounders: Age, Gender, Race, Income, Wealth, Parental Education, Learning Disabled (1997 Youth Survey)				
Academic: Cognition	**Cognitive Score**	**Cognitive Examination (1998 or 1999)**	**Computer Assisted Technology - Armed Services Vocational Aptitude Battery**	**Percentile**

Academic: School Attendance	**School Absences**	**1999-2001 Transcript Survey and 1997 Youth Survey**	**Reported or Determined Absences in School**	**Maximum number of absences in Academic Year: 1999, 2000, 2001 or Fall Term: 1997**
Academic: School Achievement	**Repeated Grade**	**Youth Surveys (Cumulative)**	**Repeated Grades in Elementary, Middle and High School**	**Number of Repeated Grades**
Academic: School Achievement	**Grade Point Average**	**Transcript Surveys (Cumulative)**	**Grade Point Average from High School Transcripts**	**Grade Point Average (0.0 – 5.0)**
Psychosocial: Mental Health	**Depressive Symptoms Score**	**Inventory, 2000 and if missing 2002**	**Mental Health Inventory – 5**	**Transformed Scores on 0 – 100 Scale**
Psychosocial: Substance Abuse	**Alcohol Smoking and Marijuana**	**1997 Youth Survey**	**Ever Used?**	**1) All Three, 2) At Least One 3) Never Used**
Psychosocial: Being Bullied	**Victim of Bullying**	**1997 Youth Survey, 1999 Youth Surveys**	**Were you a victim of repeated bullying?**	**Yes/No**
Psychosocial: School Safety	**Feeling Safe at School**	**1997 Youth Survey**	**Do you feel safe at school?**	**Strongly Agree, Agree, Disagree, Strongly Disagree**
Neighborhood	**Crime**	**Geocoded Disc (county –level residence 1997)**	**Murder Index, Total Crime Index and Aggravated Assault Index (2000)**	**Easy Analytic Software Inc. 2000, Scales, SimplyMap**
Neighborhood	**Education**	**Geocoded Disc (county residence 1997) Onsite Access (census tract residence 1997)**	**HS degrees percentage (Census 2000)**	**Percentage of HS degrees (county and census tract)**

Neighborhood	Medical Access	Geocoded Disc (county –level residence 1997)	Medical Index (2008)	Easy Analytic Software Inc. 2008, Scales, SimplyMap
Neighborhood	Income	Geocoded Disc (county residence 1997) Onsite Access (census tract residence 1997)	Median Income (1999)	Median Income, Census 2000
School	Type	School Surveys (1996 Long and if missing 1996 Short form, 2000 form)	School Type	Private, Public
School	Type	School Surveys (1996 Long and if missing 1996 Short form, 2000 form)	Length of School Year and Day	Year: Days, Day: Hours, Minutes
School	Type	1997 Youth Surveys	School Type	Public, Private and Parochial, Other
School	Type	School Surveys, 1996 (long) and if missing 2000	English as Second Language	% in Limited English Proficient
School	Type	School Surveys, 1996 (long) and if missing 2000	Race/ Ethnicity	School Racial Breakdown
School	Type	School Surveys, 1996 (long) and if missing 2000	Class Size, 1996 (long) and 2000	Number of Students Enrolled/Number of Teachers
School	Quality of Teaching	School Surveys, 1996 (long) and if missing 2000	Teacher Experience	Teachers with 10 or more years experience/ Number of Teachers
School	Quality of Teaching	School Surveys, 1996 (long) and if missing 2000	Teachers with Advanced Degrees	Teachers with beyond Bachelor Degree/ Number of Teachers

School	**Quality of Teaching**	**School Surveys, 1996 (long) and if missing 2000**	**Teacher Turnover**	**Teachers who taught five years ago/ Number of Teachers**
School	**School Environment**	**School Surveys, 1996 (long) and if missing 2000**	**Environment**	**Percentage truant on a typical school day**
School	**School Environment**	**School Surveys, 1996 (long) and if missing 2000**	**Academic Environment**	**Average SAT scores, Credits for Graduation**
School	**School Environment**	**School Surveys, 1996 (long) and if missing 2000**	**Social Environment**	**Percentage of students that possess either alcohol or illegal drugs**
School	**School Environment**	**School Surveys, 1996 (long) and if missing 2000**	**Social Environment**	**Number of Physical Conflicts, Number of Physical and Verbal Abuses of Teachers**
School	**School Environment**	**School Surveys, 1996 (long)**	**Affective Environment – 1996 (long)**	**Scale, Teachers Involved in Curriculum and Evaluating Teachers**
School	**Student Mobility**	**School Surveys, 1996 (long)**	**Student Movement - 1996 (long)**	**Number of Students Enrolled or Left School During the Year/Total Number of Students**

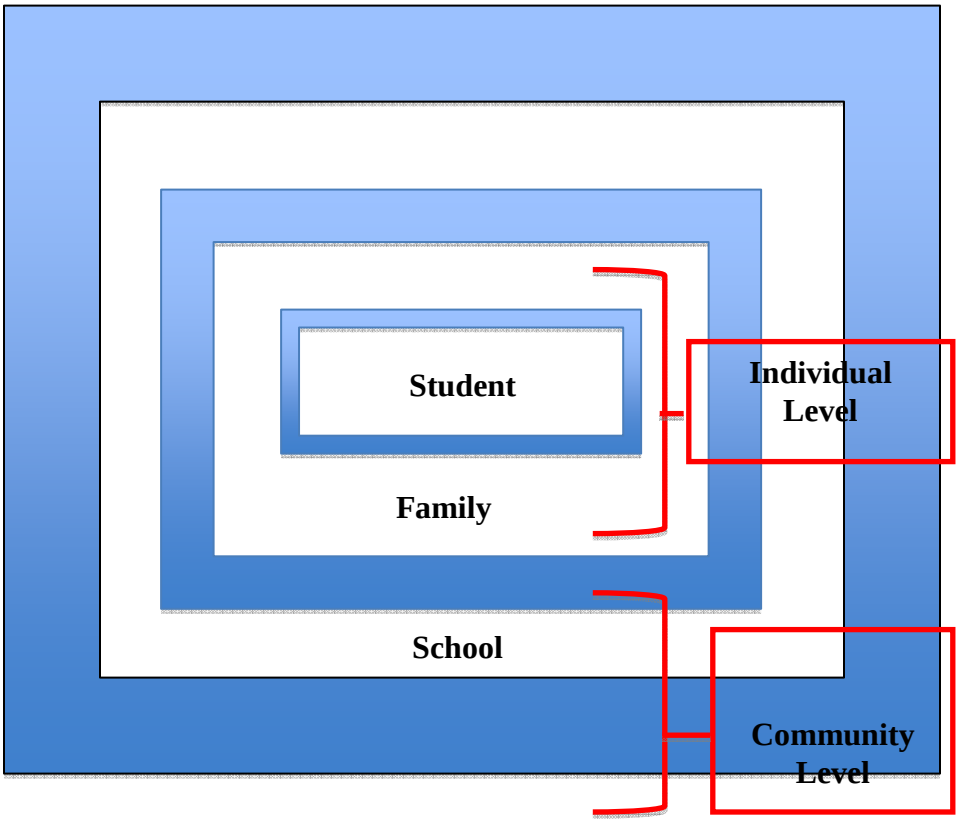
Appendix B: Paper 2, Variables Implemented In NLSY'97

Type	Measure	Question(s)	Responses
Exposure			
Chronic Health - 1997 Parent Survey	**Onset**	**When Noticed**	**Age of Participant**
Chronic Health – 2002 Youth Survey	**Onset**	**When Noticed**	**Age of Participant**
Chronic Health -1997 Parent Survey	**Limited**	**Does Condition Limit Youth**	**A lot, A little, No**
Chronic Health – 2002 Youth Survey	**Limited**	**Does Condition Limit Youth**	**A lot, A little, No**
Outcome			
Educational Attainment – Youth Survey	**High School or GED Completion**	**High School Completion – (Cumulative)**	**20 years or younger when Completing High School**
Potential Confounders	**Age, Gender, Race/Ethnicity, Income, Wealth,, Mother and Father Education, Learning Disabled (Youth - 1997)**		
Influences	**Academic, Psychosocial, Neighborhood, and School**		

Appendix C: Paper 3, Variables Implemented In NLSY'97

Type	Measure	Question(s)	Responses
Exposure			
Chronic Health – 1997 Parent Survey	**Ever have a Chronic Condition and Type**	**Type of Chronic Conditions**	**Type of Chronic Conditions**
2002 Youth Survey	**Ever have a Chronic Condition and Type**		**Asthma, Cancer, Heart Condition, Anemia, Epilepsy, Diabetes, HIV, Sexually Transmitted Disease, Other**
Outcome			
Educational Attainment –Youth Surveys	**High School or GED Completion**	**High School Completion – (Cumulative)**	**20 years or younger when Completing High School**
Potential Confounders	**Age, Gender, Race, Income, Wealth, Mother and Father Education, Learning Disabled (Youth - 1997)**		
Potential Effect Modifiers	**Neighborhood, and School**		

Appendix D: Social Ecological Model, Factors Involved In Manuscripts



Individual – Student's Background: Gender, Race/Ethnicity, Age
Individual – Student's Background: Parent's Education, 2-Parent Household
Community – School: 5-Year Teacher Turnover, Percentage of Non-Hispanic White Students, Percentage Truancy, Percentage with Advanced Degrees, School Type
Community – Neighborhood: Neighborhood Income and Neighborhood Education

Appendix E: Table, Missing Data Analysis (Paper 1)

	Overall n=8984 %/mean (SE)	Analytic Sample n=6795	Analytic with School/ Neighborhood Sample n=3456	Missing Values from School Analysis, n=4387	Missing Values n=5528	P-values Col 3 vs. Col 5
Total	100%					
Chronic Health Condition						p=0.16
Did not ever have a Chronic Health Condition	77.83%	77.93%	78.58%	77.26%	77.09%	
Ever had a Chronic Health Condition	22.17%	22.07%	21.42%	22.74%	22.91%	
Asthma	14.10%	14.25%	13.56%	14.81%	14.63%	p=0.16
Cancer/Diabetes/Epilepsy	1.86%	1.76%	1.77%	1.70%	1.95%	
Cancer	0.70%	0.67%	0.72%	0.65%	0.68%	
Diabetes	0.70%	0.68%	0.71%	0.61%	0.70%	
Epilepsy	0.46%	0.42%	0.35%	0.44%	0.56%	
Heart and Cardiovascular Conditions	1.52%	1.51%	1.62%	1.45%	1.42%	
Other (HIV, Kidney, Other)	2.58%	2.34%	2.29%	2.69%	2.86%	
Allergies/Anemia/Infectious Disease/Sexual Transmitted Diseases	2.11%	2.21%	2.18%	2.09%	2.05%	
Age- Cumulative Months-January 1, 1997(n=8984)	30.55	30.55	24.56	37.75	34.50	p<0.01
Race/Ethnicity						p<0.01
Black	15.40%	14.94%	13.67%	16.95%	16.55%	
Hispanic	12.86%	12.03%	11.50%	13.45%	13.75%	
Mixed Race	1.23%	1.04%	0.88%	1.27%	1.46%	
Non-Hispanic, Non-Black	70.50%	71.99%	73.94%	68.32%	68.24%	
Gender						p=0.12
Male	51.32%	50.66%	50.14%	51.72%	52.10%	
Female	48.68%	49.34%	49.85%	48.28%	47.90%	
Parent's Education (Highest Grade) (n=8503)	13.58	13.72	13.88	13.43	13.37	p<0.01
2-parent household						p=0.06
No	47.06%	45.30%	46.05%	48.08%	48.62%	
Yes	52.94%	54.70%	53.95%	51.92%	51.38%	

Appendix F: Table, Missing Data Analysis, Academic and Psychosocial (Paper 1)

	Overall n=8984 %/mean (SE)	Analytic Sample n=6795	Analytic Sample with Academic Values n=4109	Missing Values and Academic Values n=4875	Analytic Sample With Psychosocial, n=6617	Missing Values and Psychosocial Values, n=2367
Total	100%					
Chronic Health Condition						
Did not ever have a Chronic Health Condition	77.83%	77.93%	78.93%	76.18%	78.69%	66.86%
Ever had a Chronic Health Condition	22.17%	22.07%	21.06%	23.82%	21.31%	33.14%
Asthma	14.10%	14.25%	13.44%	15.08%	13.62%	20.12%
Cancer/Diabetes/Epilepsy	1.86%	1.76%	1.60%	2.24%	1.68%	4.18%
Cancer	0.70%	0.67%	0.60%	0.85%	0.63%	1.59%
Diabetes	0.70%	0.68%	0.73%	0.67%	0.63%	1.58%
Epilepsy	0.46%	0.42%	0.27%	0.72%	0.41%	1.01%
Heart and Cardiovascular Conditions	1.52%	1.51%	1.71%	1.235	1.49%	1.92%
Other (HIV, Kidney, Other)	2.58%	2.34%	2.28%	2.64%	2.31%	3.83%
Allergies/Anemia/Infectious Disease/Sexually Transmitted Diseases	2.11%	2.21%	2.03%	2.63%	2.21%	3.09%
Age- December, 31 1996 (n=8984)	30.55	30.55	29.94	31.11	31.44	28.19
Race/Ethnicity						
Black	15.40%	14.94%	13.43%	17.24%	14.93%	16.82%
Hispanic	12.86%	12.03%	10.06%	15.45%	12.01%	15.35%
Mixed Race	1.23%	1.04%	0.84%	1.59%	1.02%	1.84%
Non-Hispanic, Non-Black	70.50%	71.99%	75.67%	65.72%	72.05%	66.00%
Gender						
Male	51.32%	50.66%	49.77%	52.76%	50.67%	53.22%
Female	48.68%	49.34%	50.23%	47.24%	49.33%	47.78%
Parent's Education (Highest Grade) (n=8503)	13.58	13.72	14.01	13.14	13.73	13.07
2-parent household						
No	47.06%	45.30%	42.14%	51.62%	45.16%	52.62%
Yes	52.94%	54.70%	57.86%	48.38%	54.84%	47.38%

Appendix G: Table, Missing Data Analysis (Paper 2)

	Overall n=8984 %/ mean	Missing Values Neigh/ School n=5574 (Limited)	Compare to Analytic sample	Missing Values Neigh/ School n=5558 (Onset)	Compare to Analytic sample	Missing Values Neigh/ School n=5600 (Both)	Compare to Analytic sample
Total **Chronic health Condition**	100%						
Limited			P=0.11				
Limited A Lot/A Little	8.30%	8.71%					
Not Limited	10.50%	10.85%					
No Chronic Condition	81.20%	80.44%					
Onset					P=0.09		
Early Onset (12 and younger)	14.48%			15.37%			
Later Onset (13 and older)	4.91%			4.82%			
No Chronic Condition	80.61%			77.74%			
Limited and Onset							P=0.06
Early Onset and Limited A Lot/A Little (High Duration)	6.01%					6.56%	
Early Onset or Limited A Lot/A Little	9.62%					9.83%	
Not Limited and Not Early Onset	2.61%					2.60%	
No Chronic Condition	81.76%					81.01%	
Age- January 1, 1997(n=8984)	30.55	34.37	P <0.01	34.44	P <0.01	34.32	P <0.01
Race/Ethnicity			P<0.01		P <0.01		P <0.01
Black	15.40%	16.46%		16.60%		16.52%	
Hispanic	12.86%	13.67%		13.73%		13.66%	
Mixed Race	1.23%	1.44%		1.45%		1.44%	
Non-Hispanic, Non-Black	70.50%	68.43%		68.22%		68.38%	
Gender			p=0.07		p=0.13		P=0.08
Male	51.32%	52.23%		52.09%		52.18%	
Female	48.68%	47.77%		47.91%		47.82%	
Parent's Education (Highest Grade) (n=8503)	13.58	13.37	P <0.01	13.37	P <0.01	13.37	P <0.01
2-parent household			P =0.06		P =0.06		P =0.06
No	47.06%	48.60%		48.67%		48.67%	
Yes	52.94%	51.40%		51.33%		51.33%	

Appendix H: Table, Missing Data Analysis, Academic and Psychosocial (Paper 2)

	Overall n=8984 %/mean	Missing Values – Academic n=3945 (Limited)	Missing Values – Academic n=5163 (Onset)	Missing Values – Both n=3968 (Limited)	Missing Values – Both n=5188 (Onset)	Missing Values – Both n=5202 Limit/Onset
Total	100%					
Chronic health						
Did not ever have a Condition	77.83%	70.54%	74.52%	70.57%	74.07%	73.67%
Reported a Chronic Condition	22.17%	29.46%	25.48%	29.43%	25.93%	26.33%
Limited						
Limited A Lot/A Little	8.30%	9.46%		9.51%		
Not Limited	10.50%	12.91%		12.80%		
No Chronic Condition	81.20%	77.62%		77.68%		
Onset						
Early Onset (12 and younger)	14.48%		15.89%		16.25%	
Later Onset (13 older)	4.91%		5.67%		5.84%	
No Chronic Condition	80.61%		75.96%		75.48%	
Limited and Onset						
Early Onset and Limited A Lot/A Little (High Duration)	6.01%					6.58%
Early Onset or Limited A Lot/A Little	9.62%					9.93%
Not Limited and Not Early Onset	2.61%					3.39%
No Chronic Condition	81.76%					80.10%
Age- January 1, 1997(n=8984)	30.55%	30.74%	31.82%	30.69%	31.74%	31.71%
Race/Ethnicity						
Black	15.40%	18.21%	17.69%	18.25%	17.63%	17.61%
Hispanic	12.86%	15.84%	15.26%	15.80%	15.21%	15.16%
Mixed Race	1.23%	1.52%	1.54%	1.51%	1.53%	1.53%
Non-Hispanic, Non-Black	70.50%	64.43%	65.51%	64.44%	65.63%	65.70%
Gender						
Male	51.32%	53.60%	53.00%	53.58%	52.97%	53.03%
Female	48.68%	46.40%	47.00%	46.42%	47.03%	46.99%
Parent's Education (Highest Grade) (n=8503)	13.58	12.99	13.13	13.00	13.14	13.14
2-parent household						
No	47.06%	53.53%	51.70%	53.52%	51.71%	51.77%
Yes	52.94%	46.46%	48.30%	46.48%	48.29%	48.23%

Appendix I: Table, Paper 1 - Missing

Individual	OR 95% CI	School/Neigh, n=3339/5528	Academics, n=2686/4875	Psychosocial, n=178/2367
Chronic health	Ever had a chronic condition?	1.45 (1.10 - 1.90)	1.57 (1.26 – 1.95)	2.50 (1.15 – 5.44)
	Never reporting a chronic condition	(ref)	(ref)	(ref)
Race/Ethnicity	Black, Non-Hispanic	1.11 (0.84 - 1.48)	1.18 (0.87 – 1.60)	1.40 (0.55 – 3.57)
	Hispanic	0.86 (0.61 - 1.22)	0.72 (0.53 - 0.98)	0.94 (0.31 – 2.82)
	Non-Hispanic, Non-Black	(ref)	(ref)	(ref)
Gender	Female	0.87 (0.70 - 1.08)	0.78 (0.62 - 0.98)	0.78 (0.34 – 1.80)
	Male	(ref)	(ref)	(ref)
Age	Age	0.99 (0.98 - 1.00)	0.99 (0.99 – 1.00)	1.01 (0.99 – 1.04)
Family	Parent's Education	0.76 (0.73 - 0.79)	0.76 (0.73 - 0.79)	0.88 (0.77 – 1.01)
2-parent household	Yes	0.41 (0.33 - 0.52)	0.43 (0.35 - 0.52)	0.88 (0.41 – 1.89)
	No	(ref)	(ref)	(ref)

Abbreviations: CI: confidence interval; GED: general equivalency diploma, OR: Odds Ratios, (ref): reference group

Appendix J: Table, Paper 2 - Missing Limited and Onset

Individual	OR 95% CI	School/Neigh, n=3291/5574	Academics, n=1662/3945	Psychosocial, n=36/2319
Chronic health	Limited by chronic condition?	1.45 (0.99 – 2.12)	1.49 (0.89 – 2.48)	N/A
	Not limited by chronic condition	1.08 (0.77 – 1.52)	1.06 (0.70 – 1.62)	N/A
	Does Not Report	(ref)	(ref)	N/A
Race/Ethnicity	Black, Non-Hispanic	1.11 (0.82 - 1.49)	1.22 (0.83 – 1.79)	N/A
	Hispanic	0.84 (0.57 - 1.23)	1.09 (0.71 - 1.66)	N/A
	Non-Hispanic, Non-Black	(ref)	(ref)	N/A
Gender	Female	0.85 (0.68 - 1.06)	0.91 (0.70 - 1.20)	N/A
	Male	(ref)	(ref)	N/A
Age	Age	0.99 (0.98 - 1.00)	0.99 (0.98 – 1.00)	N/A
Family	Parent's Education	0.74 (0.71 - 0.78)	0.82 (0.77 - .87)	N/A
2-parent household	Yes	0.39 (0.31 - 0.49)	0.39 (0.29 - 0.52)	N/A
	No	(ref)	(ref)	N/A

Abbreviations: CI: confidence interval; GED: general equivalency diploma, OR: Odds Ratios, (ref): reference group

Individual	OR 95% CI	School/Neigh, n=3312/5558	Academics, n=2917/5163	Psychosocial, n=81/2327
Chronic health	Early Onset 12 or younger	1.69 (1.24 – 2.28)	1.57 (1.16 – 2.13)	N/A
	Later Onset	1.04 (0.61 – 1.76)	1.17 (0.77 –1.77)	N/A
	Does not report condition	(ref)	(ref)	N/A
Race/Ethnicity	Black, Non-Hispanic	1.12 (0.84 - 1.49)	1.10 (0.81 – 1.49)	N/A
	Hispanic	0.87 (0.61 - 1.23)	.88 (0.65 - 1.20)	N/A
	Non-Hispanic, Non-Black	(ref)	(ref)	N/A
Gender	Female	0.89 (0.72 - 1.11)	0.85 (0.69 - 1.05)	N/A
	Male	(ref)	(ref)	N/A
Age	Age	0.99 (0.98 - 1.00)	0.99 (0.98 – 0.99)	N/A
Family	Parent's Education	0.76 (0.72 - 0.79)	0.82 (0.77 - 0.87)	N/A
2-parent household	Yes	0.41 (0.33 - 0.51)	0.39 (0.32 - 0.48)	N/A
	No	(ref)	(ref)	N/A

Appendix K: Loss to Follow Up

Average Follow Up Periods (in Rounds)

Missing	Healthy	Chronic Health Condition
8.80	10.73	10.52
1788	5638	1558

Appendix L: Hypothesized Importance of Variables

Tier 1 (Core Variables)	Tier 2 (Principal Variables)	Tier 3 (Other Variables)
Exposure	Victim of Repeated Bullying	Student Mobility at the School
Highest Parent/Guardian Education Level	Grade Point Average	Academic Environment at the School
Age of Participant	Household Income	Affective Environment at the School
Sex	Cognitive Score	Social Environment at the School
Race/ethnicity of participant	Depressive Symptoms Score	Teacher Turnover
	Substance Abuse	Teacher Advanced Degrees
	Race/ethnicity of the Neighborhood	Length of School Year and Day
	Average Income of the Neighborhood	Racial Breakdown of School
	Percentage with HS degrees in Neighborhood	Poverty of School
	School type	Medical Index of the Neighborhood
	Teacher Experience	Murder Index of the Neighborhood
	Class Size	Feeling Safe at School
	2-Parent household	Repeated Grade
		Learning Disabled
		Household Wealth

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