

Health in Childhood and Adolescence and High School Dropout

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Abstract

There is ample evidence that poor health in childhood and adolescence is associated with higher risk of dropping out of high school. This association is suggestive of a causal effect of health problems on dropout and a potential role for health interventions to reduce the proportion of high school students who drop out. Interventions with such a dual benefit—improving health while decreasing dropout—would be important policy priorities. With the goal of identifying strategic priorities in the development of health interventions to reduce dropout, this review examines research on the effect of specific health conditions on dropout and evidence that existing intervention programs that target these health conditions are effective in reducing dropout rates. The review examines physical and mental disorders as well as two other conditions, pregnancy and obesity, that, while not disorders, may benefit from medical intervention. For each condition we examine the hypothesized pathways through which education may be affected and provide a balanced evaluation of existing evidence from observational and intervention studies of the potential positive effect of interventions on dropout.

Introduction

There is ample evidence that poor health in childhood and adolescence is associated with higher risk of dropping out of high school. Haas et al., for instance, found that students who rated their own health as fair or poor in middle school were more likely to drop out than students who rated their own health as good or excellent, even after accounting for adverse effects of low familial socioeconomic status on both health and educational attainment (Haas and Fosse, 2008). This association is suggestive of a causal effect of health problems on dropout and a potential role for health interventions to reduce the proportion of high school students who drop out. Interventions with such a dual benefit—improving health while decreasing dropout—would be important policy priorities (Hanson, Austin et al., 2004; Freudenberg and Ruglis, 2007; CESP, 2009).

Identifying the association between poor health and dropout is only the first step towards the development of interventions that might reduce dropout by improving health. Effective interventions would need to target specific health conditions with specific clinical practices. The most likely target conditions are those that have an appreciable population-level effect on dropout by virtue of high prevalence among students or particularly strong negative effects on education. The clinical practices must then be able to address the link between the target condition and the particular educational consequences that lead to dropout. Moreover, the intervention would need to be delivered in settings where large numbers of school-age children can be treated, most likely in schools. Delivering a health intervention in schools requires models of care that make efficient use of clinical resources and expertise within existing educational systems.

With the goal of identifying strategic priorities in the development of health interventions to reduce dropout, this review examines research on the effect of specific health conditions on dropout and evidence that existing intervention programs that target these health conditions are effective in reducing dropout rates. The review examines physical and mental disorders as well as two other conditions, pregnancy and obesity, that, while not disorders, may benefit from medical intervention. For each condition we examine the hypothesized pathways through which education may be affected and provide a balanced evaluation of existing evidence from observational and intervention studies of the potential positive effect of interventions on dropout. Where studies have directly examined dropout, defined as failure to complete High School on time, we review this evidence. However, for many disorders the only evidence we have regarding a potential effect on dropout consists of studies examining intermediate educational outcomes, such as school attendance and academic achievement. Where studies of dropout are lacking, we review evidence of a causal impact of health on these intermediate outcomes.

Health and Education in Childhood and Adolescence

How might health in childhood and adolescence have an impact on dropout? Dropout occurs in high school, but it is most often the outcome of a long term process that begins early in a student's educational career (Alexander, Entwisle et al. 1997; Alexander, Entwisle et al. 2001; Rumberger 2004). The ultimate decision to leave school prior to high school graduation is influenced by multiple factors occurring at different points in time: family composition and socioeconomic status, parental education and educational expectations for their children, school quality, and non-health-related individual factors including school engagement, peer networks, academic performance, and grade retention. Health status is also a "moving target" with different potential impacts at different points in students' educational careers. Some health conditions, such as asthma or attention deficit hyperactivity disorder (ADHD) often begin in early childhood and may begin to negatively affect academic performance from the very beginning of schooling (Spira and Fischel 2005). Given the cumulative nature of learning across grade levels, early disadvantages in learning may limit achievement in later class grades and test scores. Students who earn poor grades and test scores are, in turn, more likely to leave school prior to high school graduation (Chen and Kaplan, 2003).

For other health conditions, however, the connection with dropout may be quite different. For instance, conditions that begin in adolescence, such as substance use disorders or pregnancy, occur much closer in time to the actual decision to drop out of high school. While these conditions impose enormous burdens on students that compete with their ability to perform academically, they also occur after students have embarked on educational trajectories that may have already limited their likelihood of graduating from high school. In particular, poor school performance tends to precede the onset of many adolescent risk behaviors, including substance use and early sexual intercourse. If students who become substance dependent or pregnant are already unlikely to graduate from high school, then interventions that treat *only their health condition* would be unlikely to have a positive effect on dropout.

In fact, many factors that predict poor health in childhood and adolescence also predict low academic attainment and achievement. Children from low socioeconomic status (SES) families, whose parents have lower educational attainment, or who are African-American or Hispanic, are more likely to have serious chronic diseases in childhood (Chen, Martin et al., 2006; Hanson and Chen, 2007) and less likely to graduate from high school (Rumberger and Lim, 2008). In some cases the relationships can be quite complex. For instance, children from low SES families may have poor health due to associations with exposure to environmental pollutants (Evans and Kantrowitz, 2002; Gee and Payne-Sturges, 2004; Payne-Sturges and Gee, 2004), and they may be more likely to dropout because they attend schools of poorer quality. The confounding of the relationship between health and dropout that results from these associations presents a challenge to observational studies that try to isolate the level of risk attributable to health. When these factors are taken into account it is likely that estimates of the association

between health conditions and dropout will be reduced. However, it is also likely that the impact of early environmental factors on health and subsequent adverse impact of health on education may account for some of the association between family socioeconomic status and dropout.

Scope of the Review

The goal of this review is to identify potential targets for health interventions for school age children and adolescents. In accordance with this goal, the review examines health conditions that are likely to have an impact during this period that could be addressed by providing health care to children. Three types of health conditions are examined: physical diseases, mental disorders, and non-disease conditions that might benefit from clinical intervention—obesity and pregnancy. Several types of health conditions that may have effects on education were excluded from the review. First, we do not review disorders that are characterized primarily by intellectual or educational limitations, such as mental retardation or learning disability or specific environmental exposures with effects on intellectual function, such as lead (Lanphear, Hornung et al., 2005). Second, we do not review studies of perinatal health (e.g., low birth weight) or parental health because these conditions are not potential targets for intervention among school-age children or adolescents. The impact of perinatal and parental and health on educational attainment is examined in a recent review by Currie (Currie, 2009).

An initial literature review was conducted to identify candidate health conditions with hypothesized effects on educational attainment. A list of candidate conditions was drawn up based on literature reviews and consultation with physicians. Literature searches were then conducted to identify studies comparing the academic outcomes between representative samples of people with each condition to population samples. The search was conducted using the Web of Science search engine with the candidate conditions as search terms, along with multiple terms for educational outcomes including ‘dropout’, ‘achievement’, ‘educational attainment’, and ‘schooling’. Review papers, including systematic reviews were included. References and citations of publications found in initial searches were examined for additional relevant studies. Abstracts for all references were read by the principal author and papers meeting the review criteria were examined in detail. The review does not reference every study found through this process, but rather critically examines key arguments and evidence connecting each health condition with high school dropout. Where differences exist across studies, contrasting evidence is presented. Because of our interest in the U.S. dropout problem, the review is focused on studies conducted in the U.S. Some studies in other countries, where available, are also discussed.

Physical Health Conditions

Asthma

Asthma is a chronic respiratory illness common in children, which is characterized by episodic flares of acute wheezing, coughing and/or respiratory distress. Based on a combination of self-report survey data, hospital records, and vital statistics, the U.S. Centers for Disease Control (CDC) estimates that 9.1% of U.S. children have asthma, and that the prevalence of asthma increased between 1980 and 2000 since when it has remained relatively constant (Akinbami, Moorman et al., 2009). Asthma is more common among males compared to females, non-Hispanic Blacks compared to non-Hispanic Whites, among the poor compared with the non-poor, and among people in the Northwest region of the U.S. compared to those in other regions (Moorman, Rudd et al., 2007). Other epidemiological studies have found that asthma is less common among children who were born outside of the U.S. than among children born in the U.S. (Eldeirawi, McConnell et al., 2005; Holguin, Mannino et al., 2005; Brugge, Lee et al., 2007).

There has been a long-term concern with the effect that asthma might have on children's education, in particular through an adverse effect on school attendance. Children with asthma may stay home from school when they have acute episodes and these school absences may adversely affect their learning. In the early 1990s, Fowler and colleagues found that children with asthma missed three times as many days of school as children without asthma (7.6 days vs. 2.5 days) (Fowler, Davenport et al., 1992). Subsequent studies have found similar results in the U.S. (Newacheck and Halfon, 2000) and in countries of the Middle East (Saudi Arabia [Al-Dawood, 2002], Qatar [Bener, Kamal et al., 2007], United Arab Emirates [Bener, Abdulrazzaq et al., 1994], Israel [Shohat, Graif et al., 2005]) and Europe (Scotland [Austin, Selvaraj et al., 2004], France [Leroux, Bourderont et al., 1995], The Netherlands [Spee-Van Der Wekke, Meulmeester et al., 1998]). Estimates of the number of absentee days per school year attributable to asthma in these studies range from about 3 to 10. Further evidence of an effect of asthma on school absence is provided by studies of daily variations in airborne pollutant levels and aggregate school absence records, which show that school absences are higher following days with high levels of pollutants (Gilliland, Berhane et al., 2001). This finding is important because it is not affected by ascertainment of asthma. One notable exception to this pattern of results, a study of a school district in Texas, found no difference in school absence associated with asthma (Millard, Johnson et al., 2009).

Differences across studies may reflect methodological differences across studies, such as variations in control groups, but they may also reflect differences across populations in access to medical care and in adherence to prescribed treatment. Asthma flares can and should be

prevented or have their effects minimized through treatments that are widely available. In the absence of barriers to care or to adherence to medical advice, children with asthma should not be more likely to miss school. There is evidence that the impact of asthma on education is stronger in populations that are disadvantaged with respect to medical care. For instance, in the study by Fowler and colleagues cited above, asthma was associated with a doubling of risk for grade retention among low-income families, but asthma was not associated with grade retention among middle and high income families (Fowler, Johnson et al., 1985). There is evidence that the impact of asthma on school attendance is worse for groups with less access to care (Milton, Whitehead et al., 2004). This pattern is also evident in data from the California Health Interview Survey shown in Figure 1.

School absence is considered a potential link between asthma and dropout because of its impact on academic achievement; students learn less because they spend less time in the classroom. The link between school absence and achievement in the general student population is well supported by research (Lamdin, 1996). However, studies have not found that students with asthma have lower scores on standardized achievement tests than their peers without asthma. For instance, Moonie et al (2008) examined the association of asthma with absenteeism and performance on the Missouri Assessment Program, a system of grade-appropriate standardized tests, in 3,812 students age 8 to 17. They found that absenteeism was associated with low achievement and that asthma was associated with an increase of 1.5 absentee days per year per child. However, they also found that asthma was not associated with performance on the achievement test. This finding suggests that though students with asthma may miss school because of their illness, they are also likely to compensate academically for those absences through other means and avoid the long term adverse impacts on achievement. Similar results have been found in other studies (Silverstein, Mair et al., 2001; Taras and Potts-Datema, 2005).

If asthma is not a cause of lower academic achievement, as the evidence suggests, it is unlikely to be a major contributor to dropout. Nonetheless, there are two important reasons to continue to consider the potential positive effects of treatment interventions for asthma on dropout. First, the absence of an effect of asthma on dropout may in part reflect the effectiveness of current programs in managing asthma symptoms that would otherwise have an adverse impact on education. In particular, school-based programs that provide treatment to children who would otherwise lack access to care or face difficulties complying with treatment recommendations may provide critical supports for vulnerable children (Bruzzese, Evans et al., 2009). Second, treatment programs, particularly those based in schools, might have non-specific effects on education. For instance, contact with health professionals in school might bring to light other problems that students are facing that cause difficulties in school. The fact that risk factors for asthma are similar to risk factors for dropout means that children identified with asthma in schools are a high dropout risk group.

Type 1 Diabetes

Type 1 diabetes is a chronic disorder of insulin production that typically begins in childhood. The SEARCH study, a large multi-center observational study of diabetes among U.S. children (Pettitt, Bell et al., 2004), found that the prevalence of type 1 diabetes varies across ethnic groups. The prevalence per 1,000 children age 10 to 19 was 2.89 among non-Hispanic Whites, 2.04 among non-Hispanic Blacks, 1.59 among Hispanics, 0.77 among Asian-Pacific Islanders, and 0.28 among Navajo (Mayer-Davis, Bell et al., 2009). Children with type 1 diabetes are at risk for excessively low or high blood sugar levels, with severe episodes resulting in seizures or coma. As with asthma attacks, however, severe episodes are relatively rare with appropriate medical management. To prevent such episodes, patients must take injections of insulin, usually twice a day, or use an insulin pump, a device which automatically injects smaller doses of insulin at pre-set intervals throughout the day. Concerns with respect to educational attainment have arisen for two reasons: evidence of adverse cognitive effects of recurrent hypoglycemia (Bade-White and Obrzut, 2009), particularly in early childhood, and stresses related to day to day management of the disease.

Evidence for cognitive effects of hypoglycemia (low blood sugar) comes from studies that have compared diabetics with and without episodes of severe hypoglycemia. Hannonen and colleagues (2003) compared a group of 11 diabetic children with histories of severe hypoglycemia with a group of 10 diabetic children who had never had severe hypoglycemia using a standard neuropsychological test battery (Hannonen, Tupola et al., 2003). Children with episodes of severe hypoglycemia were more likely to have some neuropsychological impairment, to have learning difficulties as reported by their parents and to receive special educational services. The findings of this study are consistent with those of a recent meta-analysis of studies of type 1 diabetes and cognitive function which reported deficits among children with type 1 diabetes that were relatively small but consistent across studies (Gaudieri, Chen et al., 2008). Overall cognition scores were about one-tenth of a standard deviation lower among type 1 diabetics than controls. Among diabetics, those with onset of the disease prior to age 7 had slightly lower cognitive scores and academic achievement than those with onset at age 7 or older, with differences between these two groups of about one quarter of a standard deviation in magnitude (Gaudieri, Chen et al., 2008).

These results might be attributable to socio-demographic factors predictive of academic performance. Among children with diabetes, poor disease management, including incidence of hypoglycemic episodes, is associated with low socioeconomic status and being raised by a single parent (Holmes, Cant et al., 1999; Swift, Chen et al., 2006). Hershey and colleagues used data from a randomized trial in which diabetic children were assigned to conventional or intensive therapy. The intensive therapy, which involved tight control of blood sugar level, increased risk

for hypoglycemia. In that study, the children randomized to the intensive therapy had more hypoglycemic episodes and memory impairments suggestive of neurological damage than the children randomized to conventional therapy (Hershey, Lillie et al., 2002). The finding of deficits in this randomized trial suggests that there are cognitive consequences to hypoglycemia that may lead to educational difficulties for diabetic children whose disease is not well managed.

The stress of managing diabetes on a day-to-day basis may interfere with children's ability to perform academically. As with asthma, the primary concern has been that children with diabetes are more likely to be absent from school, that absence will be detrimental to academic achievement and that ultimately children with diabetes will be more likely to drop out. A number of case control studies have found that diabetic children miss more school than their non-diabetic peers (Holmes, Dunlap et al., 1992; Overstreet, Holmes et al., 1997; Glaab, Brown et al., 2005). There are exceptions, with some studies finding no differences (Hagen, Barclay et al., 1990; Wysocki, Harris et al., 2003). Despite this evidence of academic challenges, studies that examine academic performance or educational attainment find little evidence of long term educational deficits.

A systematic review by Milton and colleagues (2004) found that in the large majority of studies of diabetes and academic achievement there is no evidence that diabetics perform poorly relative to their peers with respect to standardized test scores, grades, and grade retention. Exceptions to this pattern are evenly divided between studies showing positive and negative effects (Milton, Whitehead et al., 2004). In one of the larger studies, for instance, McCarthy and colleagues compared a group of 244 children with diabetes with two control groups, one comprised of siblings of the cases and one comprised of classmates matched on age, sex and prior test scores. Where differences in performance were found between the diabetic children and either control group, the diabetic children had higher test scores (McCarthy, Lindgren et al., 2002). Studies that have examined the total number of years of education or educational qualifications earned by diabetics relative to population-based controls have found no evidence of lower educational attainment (Lloyd, Robinson et al., 1992; Robinson, Stevens et al., 1993).

The evidence thus suggests that with current systems for medical management, type 1 diabetes does not contribute to high school dropout. However, the same cautions noted with respect to similar findings regarding asthma and dropout should be reiterated here. First, apparent lack of effect of diabetes on dropout is conditional on current systems of care remaining in place. Second, socially disadvantaged children with diabetes are much more likely to experience problems managing their disease. For these children, support for management of diabetes may an important component of support for academic advancement.

Other Chronic Childhood Diseases

A number of rare childhood diseases may have negative effects on educational attainment. Although their rarity means that even very successful interventions would not have detectable effects on dropout rates, there may be intervention strategies that are effective for children with these disorders. For each of the diseases reviewed below there is very little, if any, research that directly examines dropout. In each case we review evidence regarding the impact of the disease on cognitive function or academic performance. It is important to note that children with these disorders are commonly identified early in their school career and may receive intensive medical and educational services throughout their school years. These existing services may effectively compensate for deficits that would otherwise lead to early termination of education.

- Sickle Cell Disease (SCD)

Neurological damage from brain infarcts, blockages of blood flow through small peripheral blood vessels, occurs in a significant proportion of children with SCD. These infarcts can have cognitive consequences, but the particular functions that are impaired depend on the location in which the infarct occurs. The occurrence of cerebral infarcts in SCD is thought to be a function of disease severity rather than failure in management. Children with cerebral infarcts, confirmed through brain imaging (White and Debaun, 1998), have been found to have a range of cognitive deficits (Kral, Brown et al., 2001) and difficulties with schooling, including higher rates of grade retention, receipt of special education services (Schatz, 2004) and dropout (Schatz, Brown et al., 2001). Evidence also suggests that the impact of SCD on educational attainment may not be limited to the effects of cerebral infarcts. A meta-analysis by Schatz and colleagues arrived at a pooled estimate of the difference in IQ between children with SCD who had no cerebral infarcts and control groups comprised of either siblings or peers. Children with SCD had IQs that were 4.3 points, about one-third of a standard deviation (SD), lower than the control groups (Schatz, Finke et al. 2002).

- Epilepsy

Studies have reported academic underachievement, i.e, poor performance relative to IQ, among patients with epilepsy for several decades (Seidenberg, Beck et al., 1986).

Understanding the reasons for underperformance is complicated by the fact that epilepsy is both rare and heterogeneous. Cases vary in the location, frequency, and type of seizure and in their response to treatment with anti-epileptic drugs. There is evidence that treatment reduces the negative impact of epilepsy. A study by Williams and colleagues (2001) compared academic achievement among children with controlled epilepsy, including both mild cases and successfully medicated cases, with population norms on tests of academic

achievement (Williams, Phillips et al., 2001). In that study, children with epilepsy performed slightly worse than expected based on their IQ, but this deficit in performance was attributable to problems of attention and not to distinctive deficits of epilepsy. One implication of this finding is that academic deficits associated with epilepsy can be significantly reduced or eliminated with successful medical management of seizures.

- HIV infection

Children with HIV disease, most of whom contracted the disease prenatally, may be at risk for dropout due to neurological effects of the disease or the strain of disease management. Blanchette and colleagues (2002) compared neuropsychology test results of a small group of HIV positive children with their HIV negative siblings (Blanchette, Smith et al., 2002). No association was found between HIV disease and performance on the large majority of neurological tests, though some deficits were found among patients with brain lesions found with CT scans.

- Phenylketonuria (PKU)

PKU is a genetic disorder in which phenylalanine accumulates in the blood disrupting normal neurological development and causing severe mental retardation. Since the discovery of the cause of this disorder, dietary management has been used to avoid the buildup of phenylalanine, eliminating the most severe consequences in most cases. Concern remains however, regarding lingering effects among people with diet-controlled PKU. Epidemiologic studies suggest that there are indeed some deficits among children with PKU with respect to spelling and arithmetic performance (Chang, Gray et al., 2000), IQ (Weglage, Funders et al., 1993) and school problems (Gassio, Fuste et al., 2005). However, the one study examining high school dropout among PKU patients found them no more likely to dropout than their siblings (Weglage, Funders et al., 1993).

- Hemophilia

Hemophilia is a blood-clotting disorder which, like epilepsy, is partially controlled through medications enabling children with this disorder to lead close-to-normal lives. For example, in a population based registry of hemophilia patients in central Pennsylvania, children with hemophilia had higher than average IQ and were more likely to be enrolled in academically advanced classes than other children (Mayes, Handford et al., 1996). However, partially due to variation in successful management and partially due to differences in severity of the disorder, there is wide variation among children with hemophilia in episodes of serious bleeding. In addition, epidemiological studies have found that patients with multiple bleeding episodes are more likely to have educational problems than patients without bleeding episodes (Shapiro, Donfield et al., 2001). School absenteeism appears to be a major

contributor to these problems (Woolf, Rappaport et al., 1989; Colegrove and Huntzinger, 1994).

Mental Health

Psychiatric Disorders

Mental health problems are among the most common health conditions affecting school-age children and adolescents. A review of studies that assessed standard criteria for psychiatric disorders specified in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* (Apa, 1994) found that the median estimate of the prevalence of any psychiatric disorder prior to age 18 was about 25% (Costello, Egger et al., 2005). Given this extremely high prevalence, providing treatment for all cases of psychiatric disorder is not a feasible policy option, and additional criteria are needed to identify those children with the most severe disorders who would benefit the most from interventions. Studies with more detailed assessments of impairment due to psychiatric disorders suggest that a smaller, but still large, proportion of children have impairing psychiatric conditions. In a national survey of U.S. youth ages 4-17, seven percent had clinically significant psychiatric symptoms in addition to impairment caused by those symptoms, as rated by self-report or parent-report (Bourdon, Goodman et al., 2005).

Comorbidity is an additional challenge in identifying adverse educational consequences of mental health problems; different types of problems, which might have distinct effects on education, tend to co-occur (Angold, Costello et al., 1999). Psychiatric disorders associated with dropout can be grouped into four major types. First, internalizing disorders include those characterized by symptoms of anxiety and/or depressed mood, such as social phobia or major depression (Fletcher, 2008; Needham, 2009). Second, externalizing disorders are characterized by persistent rule-breaking, defiance of authority, and/or aggressive behaviors, such as conduct disorder or oppositional defiant disorder (Rappaport, Scanlan et al., 1999). Third, attention deficit hyperactivity disorder (ADHD) is characterized by difficulty in sustaining mental focus or physical control (Barkley, Fischer et al., 2006; Galera, Melchior et al., 2009). Fourth, substance use disorders are characterized by excessive or dysfunctional substance use or physiological symptoms of substance dependence (Breslau, Lane et al., 2008). Issues specific to substance use and substance use disorder are addressed in the following section.

Childhood psychiatric disorders are likely to share many common causes with high school dropout, including, gender, race/ethnicity, immigration status, family disruption, parental education, and parental psychiatric disorders. In general, familial characteristics that predict dropout also predict childhood psychiatric disorder, including early divorce, parental education (Muntaner, Eaton et al., 1998; Lorant, Deliege et al., 2003; Muntaner, Eaton et al., 2004), parental occupation (Gilman, Kawachi et al., 2002) and parental psychiatric disorders (Farahati, Marcotte et al., 2003). For individual characteristics, associations with dropout and psychiatric

disorder are equally strong, but more varied in direction. Males are more likely to dropout than females, but gender differences in psychiatric disorder vary across types of disorder. Females are more likely to have internalizing disorders while males are more likely to have externalizing disorders and ADHD. Minority race/ethnicity (Breslau, Kendler et al., 2005; Breslau, Aguilar-Gaxiola et al., 2006) and foreign-birth (Breslau, Aguilar-Gaxiola et al., 2007) are associated with higher risk for dropout but lower risk for psychiatric disorder.

Due to our concern with identifying particular conditions responsible for adverse educational consequences, we do not review studies that examine only one particular type of psychiatric disorder. There are two studies based on national samples of adults that have examined associations between a broad range of psychiatric disorders and high school dropout (Kessler, Foster et al., 1995; Breslau, Lane et al., 2008). Both these studies used retrospective reports of disorders and the age at which the disorders began in order to examine whether disorders were associated with subsequent dropout. This approach is designed to rule out reverse causation, i.e., the effect of dropout on psychiatric disorders. In both studies, positive associations were found between all four types of disorders described above and subsequent dropout that were sustained after statistical adjustment for potential common causes of disorder and dropout. Controls included parental educational attainment, parental mental disorders, race-ethnicity, sex, age, and an additional set of early childhood adversities such as physical abuse, sexual abuse, and child neglect. The study by Breslau et al. estimated that if the impact of mental disorders were removed from the population, dropout would be reduced by 10%.

Given comorbidity among psychiatric disorders in children, the finding that most common psychiatric disorders are associated with dropout does not have clear implications for prevention. These associations might arise from the effect of a few particular disorders with strong effects on dropout or from a broader range of disorders each of which has a moderate effect on dropout. A more nuanced understanding of which particular disorders are associated with dropout, accounting for comorbid conditions, is needed to identify the mechanisms through which mental health problems lead to dropout and to target treatment efforts.

There is accumulating evidence that in fact the broad pattern of association between psychiatric disorders and dropout is due to the effect of two particular types of disorders: externalizing disorders and ADHD. First, compared with internalizing disorders, associations of externalizing disorders and ADHD are larger in magnitude, when they are assessed separately (Breslau, Lane et al., 2008). Second, two longitudinal studies, one in New Zealand (Miech, Caspi et al., 1999) and one in upstate New York (Johnson, Cohen et al., 1999), have attempted to distinguish independent effects of internalizing and externalizing disorders on dropout. Both found that associations with dropout were sustained for conduct disorder but not for internalizing disorders, when both were examined simultaneously. Third, a recent study by the author examined the joint effects of multiple psychiatric disorders on dropout, using retrospective assessments of disorders and educational attainment in a large national sample of the U.S.

population. In that study, ADHD and conduct disorder were associated with dropout while internalizing disorders were not (Breslau, under review).

Substance Use and Substance Use Disorders

Psychiatrists and psychologists use two clinical concepts to describe syndromes of dysfunctional or maladaptive use of substances: *abuse*, which is characterized by recurrent use despite significant detrimental effects of use, and *dependence*, which is characterized by physiological symptoms of tolerance, craving and withdrawal (APA, 1994). Dependence is a more serious diagnosis in the sense that it usually, but not always, occurs in people who have previously met criteria for abuse. Tobacco differs from alcohol and illicit drugs in having no associated syndrome of abuse. Assessing the impact of these disorders on dropout is complicated by the following three issues. First, it is important to distinguish associations of substance *use* and dropout from effects of substance use *disorders* on dropout. Use of these substances is relatively common among high school students and does not in itself constitute a health problem. In a 2008 national survey, the lifetime prevalence of substance use (i.e., proportion ever having used) among adolescents ages 12-17 was 38% for alcohol, 26% for illicit drugs, and 27% for tobacco (SAMHSA, 2009).

Second, substance use disorders are strongly associated with other psychiatric disorders with effects on dropout, including ADHD and conduct disorder (Glantz, Anthony et al., 2008). Since the psychiatric disorders tend to occur prior to initiation of substance use, it is important to account for their effects before assessing whether substance use disorders are associated with additional increments of dropout risk. Third, students who use one substance are also more likely to use other substances. For example, students who drink alcohol are more likely to smoke tobacco and use illicit drugs than students who do not drink (Bray, Zarkin et al., 2000). This means that associations between any one particular substance and dropout might arise from the causal effects of other substances. In order to identify effects of disorders associated with specific substances, multiple types of substance, minimally alcohol, illicit drugs, and tobacco, should be considered simultaneously.

Alcohol use in high school is consistently associated with dropout, but studies that have attempted to isolate causal effects of drinking on dropout have found that if there is an effect it is limited to subgroups of heavy drinkers. Several early studies examined associations between state level variations in the availability of alcohol to adolescents (e.g., state alcohol taxes or drinking ages) and dropout and found some evidence that greater access was associated with higher dropout rates (Cook and Moore, 1993; Yamada and Kendix, 1996). However, subsequent studies which examined differences between siblings (Koch and Ribar, 2001), more valid measurements of potential confounders and of dropout (Dee and Evans, 2003; Koch and Mcgeary, 2005; Chatterji, 2006) , and prior use of other substances(Newcomb, Abbott et al., 2002) found much smaller effects or no effect at all. For instance, Chatterji (2006) examined data

on a longitudinally followed nationally representative sample that included 25,000 8th graders at baseline. Alcohol use in either 10th or 12th grade was associated with failure to complete high school on time, but these associations were no longer significant after adjustment for the fact that alcohol use and graduation rates are correlated within geographic regions. There remains some evidence that initiation of drinking prior to age 14 (Koch and Mcgeary), heavy alcohol use by age 16 (Staff, Patrick et al., 2008) or binge drinking in the senior year of high school (Renna, 2008) may increase risk of dropout, but none of these studies examining subgroups of drinkers have adjusted for other hypothesized adverse patterns of drinking or use of other substances.

Evidence that use of illicit drugs causes dropout is somewhat stronger than that for alcohol, but also mixed. Use of illicit drugs or of the most commonly used drug in this group, marijuana, is commonly associated with higher risk of dropout (Lynskey and Hall, 2000; Macleod, Oakes et al., 2004). As with studies of alcohol use and dropout, these associations are strongest in studies with limited statistical control for predisposing factors and multiple substance use (Bray, Zarkin et al., 2000; Van Ours and Williams, 2009). However, these associations are sustained in studies with more sophisticated statistical tests of causal effects. Three prospective cohort studies found that extensive controls for family and individual characteristics, including other substance use, did not explain the association between marijuana use and dropout (Fergusson, Horwood et al., 2003; Lynskey, Coffey et al., 2003; Chatterji, 2006). For instance, in the New Zealand birth cohort study examined by Fergusson et al (2003), greater frequency of marijuana use was associated with increasing risk of dropout, after accounting for prior mental health assessments, use of other substances and school performance. The possibility that these studies have not yet fully accounted for confounding of the drug use-dropout relationship by prior factors that have gone unmeasured should be kept in mind. In the one study that also controlled for state-level drug policies and school characteristics, the association between drug use and dropout was no longer significant (Chatterji, 2006).

Quite surprisingly, the strongest associations with dropout have been found for tobacco. Studies conducted in Canada (Georgiades and Boyle, 2007) and in the U.S. (Ellickson, Bui et al., 1998) report two consistent findings. First, associations with dropout prior to adjustment for potential confounders are of greater magnitude for tobacco use than for use of either alcohol or illicit drugs. Second, after adjustment for multiple substances, the association between tobacco and dropout is sustained while associations between other substances and dropout are greatly attenuated or null. Similarly, studies cited above that focused on illicit drug use but included adjustment for smoking also report that associations between smoking and dropout are sustained after adjustment for multiple drug use (Bray, Zarkin et al., 2000; Lynskey, Coffey et al., 2003). In the one study which distinguished effects attributable to non-specific delinquent behavior from effects attributable to use of specific substances, only tobacco had a unique relationship with dropout (Newcomb, Abbott et al., 2002).

Most researchers have argued that it is unlikely that the association between substance use and dropout is due to pharmacological effects of the substances being used. There is little evidence to suggest that any of these substances cause persistent cognitive impairment at this age (Fergusson, Horwood et al., 2003; Macleod, Oakes et al., 2004; Lynskey, 2006). Rather, the association of substance use with dropout is thought to result from a combination of: 1) factors that predict initiation of substance use that are related to school performance (Bryant, Schulenberg et al., 2003; Zimmerman and Schmeelk-Cone, 2003); and, 2) self-selection into social networks that devalue educational attainment (Fergusson, Horwood et al., 2003; Lynskey, 2006).

There is evidence that poor school performance commonly *precedes* initiation of substance use (Bryant, Schulenberg et al., 2003; Crosnoe 2006; Bachman, O'malley et al., 2008). Some students may interpret poor grades, researchers suggest, as evidence of limited prospects for future academic success, and this perception leads to disaffection from school, disinvestment from educational attainment more generally, and involvement in proscribed activities including substance use. The decrease in motivation for academic accomplishment may then be amplified through peer associations which reinforce values and reward activities that are detrimental to academic progress.

It is in this context of these findings regarding the association between substance use and dropout that the potential effect of specific clinical syndromes associated with substance use, i.e., abuse and dependence, should be considered. It may be the case, for instance, that alcohol use in the absence of abuse or dependence does not have an adverse effect on dropout, but that alcohol dependence impairs students to such a degree that they are more likely to drop out. The evidence cited above that particular high-use groups seem to be at elevated risk for dropout relative to low-use groups is consistent with this suggestion, but does not in itself implicate clinical syndromes. Only one study that we are aware of has examined whether students who meet DSM criteria for a substance use disorder are more likely to dropout of high school than students who also used substances but did not have a disorder (Breslau, Miller et al., under review).

The study by the author of this review used retrospective reports of psychiatric disorders and high school dropout to examine whether users of tobacco, alcohol and other drugs were more likely to drop out if they met criteria for either abuse or dependence (only dependence for tobacco) prior to graduation or dropout, controlling for family background and other prior psychiatric disorders (Breslau, Miller et al., under review). In that study, substance use disorder was associated with dropout only among drug users. Nicotine dependence was not associated with dropout among smokers and alcohol abuse or dependence was not associated with dropout among drinkers. However, even the finding that drug users who develop disorders are at higher risk for dropout than drug users who do not develop disorders does not necessarily indicate a causal effect of disorder. When additional statistical control was added for smoking (prior to onset of the disorder) dropout was no longer associated with disorder in the sample of drug users.

Existing evidence thus suggests that substance use disorders do not make a large unique contribution to high school dropout, but the evidence available to date is limited to a single retrospective study. Given the high prevalence of substance use and substance use disorders among high school students, much more research is needed to examine potential impacts on dropout. In particular, there is evidence that patterns of early or heavy use of substances might be particularly problematic. The primary challenge to observational studies in this area is the association of substance use with ongoing social trajectories that lead to dropout. These associations make identification of causal effects extremely difficult.

However, the close association of substance use with many negative features of adolescents' social environments also suggests there is a potential for programs that focus on substance use to have positive effects, even if substance use does not have a direct effect on dropout. For instance, programs that have non-specific effects on students by providing support, connection and mentoring by teachers and other educational professionals, may be effective in keeping students engaged with school activities. Substance use prevention programs have shown some success in reducing initiation and continuation of substance use in adolescents (Faggiano, Vigna-Taglianti et al., 2008), but only one study we found examined effects of these programs on educational outcomes (Engberg and Morral, 2006). This was a study which pooled evidence from multiple randomized trials of treatment programs to examine whether student graduates from these programs were less likely to miss school during periods when they were not using substances compared to periods in which they were using substances. The results showed a strong positive effect on desisting from substance use on school attendance. One possible implication of this study is that cessation of use involves a re-orientation to academic goals and thus involves more than a change in substance use behaviors (Lynskey, 2006). If these associated changes can have positive effects on substance users, then they might be of considerable value as public health interventions to reduce dropout. The fact that substance users comprise a group at high risk for dropout adds to the potential value of such programs.

Health Related Conditions

Pregnancy and Childbirth

The rates of pregnancy and childbirth among high school age adolescents in the U.S. have declined by about one-third since the early 1990s (Guttmacher Institute 2006), but remain quite high relative to other developed countries (Singh and Darroch, 2000). Adolescent pregnancy is strongly associated with background characteristics also associated with high school dropout, including minority race/ethnicity and low parental education (Boden, Fergusson et al., 2008), as well as more proximal factors such as dislike of school (Bonell, Allen et al., 2005). While pregnancy itself is not a poor health condition, the fact that it is a life-changing event, carries significant health risks, and requires medical intervention makes it relevant to this review. Interventions that might reduce dropout by preventing teenage pregnancy or reduce the adverse impact of pregnancy and/or childbirth on educational attainment would be of great interest.

Pregnancy and childbirth might affect educational attainment in a number of ways, but the overlap between risk factors for pregnancy and risk factors for high school dropout more generally makes identification of this effect difficult. For adolescent girls, pregnancy is at the very least a consuming distraction from educational effort, which is likely to have a negative impact on their ability to focus on academic work. Childbirth is also likely to impose enormous psychological demands and economic burdens, providing strong incentives to cease education and enter the labor market or devote time to child care, particularly when child care is expensive.

Not surprisingly, associations of teenage childbirth with dropout are very strong prior to adjustment for other predictors of dropout. For instance, a recent study of a longitudinal birth cohort study in New Zealand found that the proportion of girls who lacked a high school educational qualification by age 25 was 6.5% among those who did not have a child prior to age 21, 22.3% among those who had a child between age 18 and 21, and 59.1% among those who had a child prior to age 18 (Boden, Fergusson et al., 2008). Researchers have used a variety of methods to adjust these associations to account for pre-existing differences in likelihood of graduation across these groups. While all the studies find that the likely causal effect of teenage childbirth is much smaller than the unadjusted association, studies differ with respect to whether there is evidence for any effect at all.

Initial studies found that a relatively large association between teenage childbirth remained after statistical adjustment for family background, socioeconomic status, type of school, and academic achievement. For instance, McElroy followed a cohort of students in 10th grade in 1980 and found that after adjustment for the above factors, teenage childbirth was associated with a 40% lower probability of graduation for White girls and a 20% lower probability of graduation for Black girls (Mcelroy, 1996). Levine and Painter used a method of

matching girls who gave birth as teens with girls who had similar levels of risk for teen childbirth on the basis of a wide range of risk factors. This comparison, which provides a statistically more robust estimate of the causal effect of childbirth, found that childbirth was associated with about 20% lower probability of graduating from high school.

However, there remains concern that these studies have not adequately adjusted for family background factors that affect both dropout and childbirth. Researchers have used two additional strategies for isolating the effect of teenage childbirth from the effect of pre-existing educational trajectories. First, since family background is shared between sisters, it was reasoned that a comparison of dropout among those who had a child as a teenager and their sisters who did not would better reflect causal effects of childbirth. Two initial studies using this method found that the estimated effect of childbirth on dropout was significantly reduced relative to the previous studies but still significant (Geronimus and Korenman, 1992; Hoffman, Foster et al., 1993). For instance, Hoffman and colleagues found that the estimated effect of childbirth on dropout was reduced by about half in the analysis of sisters, relative to that in the analysis using standard statistical controls in the general population sample (Hoffman, Foster et al., 1993; Ribar, 1999). There is also reason to be concerned, however, that comparisons of dropout between sisters is too conservative. Sisters may differ from one another with respect to factors outside of their family situation, and even the family situation may change over time so that sisters are raised in substantially different family environments. These concerns were confirmed by evidence that girls who gave birth as teenagers had poorer academic records prior to becoming pregnant than their sisters who did not give birth as teenagers (Holmlund, 2005). Adjusting for these differences returns estimates of the effect of childbirth to the higher levels found in studies of general population samples.

Second, Hotz and colleagues proposed that teenagers who gave birth should be compared with teenagers who became pregnant but did not give birth due to miscarriage (Hotz, Mcelroy et al., 2005). This 'natural experiment' would provide a better estimate of the effect of childbirth if miscarriages were truly random among girls who become pregnant. In their initial study implementing this strategy, Hotz and colleagues found that the association between teenage childbirth and dropout was not sustained when the comparison group was comprised of girls who had had miscarriages as teenagers (Hotz, Mcelroy et al., 2005). However, this strategy too has been re-evaluated in light of evidence that miscarriages are correlated with other factors that influence dropout, primarily because some girls who miscarry would have terminated their pregnancies rather than given birth, and abortion is more common among girls who are more likely to graduate (Fletcher and Wolfe, 2009). In a recent study taking account of the timing of miscarriage, with additional adjustment for community level characteristics, teenage childbirth was associated with a 5-10% reduction in the likelihood of high school graduation (Fletcher and Wolfe, 2009).

Unlike substance use prevention programs, intervention programs that address the impact of childbirth on high school students have tended to focus directly on educational attainment as a primary goal. The focus on education is reflected in the intervention designs, which combine parenting training, educational assistance and coordination of medical care. For instance, Barnett and colleagues describe a program of home visits over the first two post-partum years during which case workers provided training in parenting, adolescent life-skills training (including safe-sex practices and strategies for educational success), regular assessments of mental health and academic progress, and coordination with primary care physicians (Barnet, Liu et al., 2007). Adolescent mothers randomly assigned to the program were 3.5 times more likely to stay in school over the two post-partum years than controls (Figure 2).

A number of programs with similar combinations of social, educational and clinical support have been located within schools, some involving school-based clinics or school-based childcare facilities (Strunk, 2008). In one school-based program described by Crean and colleagues, 78% of participants graduated from high school while only 28% of the waiting-list control group graduated (Crean, Hightower et al., 2001). Barnett and colleagues describe a school-based program of prenatal care in which participants were half as likely to drop out of high school than non-participants who received out of school care (Barnet, Arroyo et al., 2004).

It is notable that the impact of programs designed to reduce the negative impact of teenage childbirth on dropout appear to have positive effects that are larger in magnitude than the causal effect of teenage childbirth on dropout estimated through causal modeling of observational data. It is likely that this apparent paradox is due to the comprehensive nature of the interventions, which provide a range of services that address not only barriers to graduation posed by childbirth, but pre-existing disadvantages. Indeed it is difficult to imagine a program that would only address the impact of childbirth. Participants in these programs, who are among the most disadvantaged with respect to academic preparation, receive mentoring by a non-familial adult, economic and educational support, and supervision, all of which are likely to contribute to positive educational outcomes.

Overweight

Among children, being overweight is defined as having a body-mass Index (BMI) above the sex specific 95th percentile, according to growth charts developed by the Centers for Disease Control from data collected from the 1960s through the 1990s (Anderson and Butcher, 2006). (Although the term “childhood obesity” is also used with the same intended meaning, the CDC recommends use of the term “overweight” for children.) The prevalence of overweight school-age children tripled between the 1970s and the 2000s (NCHS, 2008). Data from repeated cross-sectional samples of U.S. children ages 2-19 shows that the prevalence of overweight children continued to increase over the four-year period 1999-2000, when it was 13.9%, to 2003-04, when it was 17.1% (Ogden, Carroll et al., 2006). Being overweight can be a contributing cause of

some disorders, such as diabetes or sleep apnea, and it can exacerbate disability associated with other disorders, such as asthma. Moreover, overweight children face severe stigmatization at school, starting from an early age. Stigma is likely to lead to dislike of school and may have a long-term impact on achievement. Effects of being overweight on dropout might arise from either of these pathways.

A systematic review of studies of the impact on education of overweight children reported no studies that examined dropout as an outcome (Taras and Potts-Datema, 2005). However, across studies available at the time there was a consistent finding that overweight children performed more poorly than normal weight children on IQ tests, math and reading achievement tests, grades, school attendance, and grade retention (Taras and Potts-Datema, 2005). Moreover, overweight students had lower expectations for their own educational prospects. For instance, a study of about 10,000 middle school students in Connecticut found that being overweight was associated with students' low opinion of their academic ability and low anticipation of completing high school (Falkner, Neumark-Sztainer et al., 2001). As with other conditions, these associations should be considered in light of consistent associations between overweight and other predictors of poor school performance. In developed countries, being overweight has a strong association with low socioeconomic status (Mclaren, 2007), and, in the U.S., overweight is more common among African-Americans and Hispanics than among non-Hispanic Whites (Wang and Zhang, 2006).

More recent studies have incorporated additional statistical controls for socioeconomic status and mental health. Datar and Sturm (2006) examined data from a longitudinal study with baseline assessments in kindergarten and follow-up assessments at grade 3 (Datar and Sturm, 2006). Accounting for socioeconomic status, prior internalizing and externalizing behaviors, and between-school variations, girls who became overweight between kindergarten and 3rd grade had lower math and reading test scores than girls who were normal weight in both kindergarten and 3rd grade. Among boys, becoming overweight was not associated with low achievement but was associated with being absent about one additional day. Recent studies have also reported that overweight students miss more days of school, are late more often and have lower GPAs than non-overweight students (Geier, Foster et al., 2007; Shore, Sachs et al., 2008).

A large number of interventions have been designed to reduce the prevalence of overweight among children and adolescents, including a wide range of interventions delivered in school settings (Yetter, 2009). A recent systematic review found 40 published studies reporting effects of school-based interventions to prevent overweight (Cook-Cottone, Casey et al., 2009). The interventions typically combine nutrition education, changes in foods offered to students in school, and promotion of physical activity. However, none of these studies included measures of academic achievement. The only intervention study to report effects on academic achievement is a recent pilot study of the EatFit program, a nutrition education curriculum. Intervention participants, who were low-income middle school students in a rural school district in California,

had higher mathematics and English test scores after the intervention than before the intervention (Shilts, Lamp et al., 2009). There may also be reason to expect positive effects on academic achievement from interventions that successfully increase physical activity due to apparent positive effects of physical activity on cognitive performance.

Discussion

Existing research provides strong evidence of associations between a wide range of specific health conditions and subsequent dropout from high school. For an additional set of health conditions there is equally strong evidence for associations with schooling problems that make dropout more likely, such as low achievement scores or absenteeism. Evidence regarding potential causal effects of health on dropout is mixed. Virtually all of the conditions examined are associated with other childhood indicators of high risk for dropout. Studies that have attempted to adjust for these prior factors in order to test for causal effects of health on dropout suggest that the conditions most likely to have an effect on dropout are psychiatric disorders, ADHD and conduct disorder in particular. Evidence from actual intervention studies, however, is quite limited, largely due to the lack of health intervention studies that assess dropout as an outcome.

The implications of these findings for design and testing of future interventions depend on the timing of the various health conditions, the hypothesized pathways thought to lead to dropout, the types of treatments that might be offered, and the relationships between the condition and other risk factors. Based on the evidence reviewed above, health conditions can be divided into three broad groups, illustrated in Figure 3, which might be targeted with different intervention strategies. First, for conditions that can be effectively managed medically, primarily childhood physical disorders, there is little evidence of adverse educational consequences at a population level. However, since these conditions require constant and often burdensome disease management, disparities in access to care or difficulties in adherence to treatment may result in negative effects on schooling among vulnerable groups of children. Second, conditions that begin early in the educational career, such as early onset psychiatric disorders and overweight, may have direct effects on learning and long-term effects on dropout. Evidence for a causal effect of health on dropout is strongest for this group of disorders. Third, risk behaviors that begin in adolescence appear to be markers of downward educational trajectories with origins in prior academic underperformance rather than causes of dropout. More research is needed, however, in order to examine potential impacts of substance use disorders and to examine the potential benefits of addressing educational failure in conjunction with substance disorder treatment. We address each of these three patterns in greater detail below.

For children with disorders that fit the first pattern, common and simple activities present serious health risks. Asthmatics are at high risk for attacks simply being outside at times of the year with low air quality. For diabetics maintaining glucose levels is a constant concern, at meals and between meals. In the not so distant past, these disorders, and other more rare disorders in this group, would have led to early death or extreme functional limitations. The finding that there are not large adverse impacts of these disorders on educational attainment is a testament to the effectiveness of existing medical treatments. However, these treatments are often onerous, requiring a high level of organization and stability within a child's family to maintain health. As

studies of treatment adherence have shown, the family environments of many children make consistent follow-through with a medical regimen difficult. For instance, the association of hypoglycemic attacks with low parental SES reflects this reality.

Despite the absence of overall effects on dropout for this group of disorders, concern still remains regarding the impact of mismanagement of illness, particularly among children whose families may have difficulties with treatment regimens. Research is needed to examine the impact that non-adherence to treatment has on schooling. Moreover, since schools are likely to provide the most stable contact with adults in the lives of many at-risk students, there may be an important role for schools in supporting disease management. Models of care that combine the regular contact and monitoring that can occur in schools with strategic input of clinical expertise may achieve positive effects on schooling for these children with a minimal burden on school administration. The clinical expertise might come from on-site school nurses supplemented with input from physicians in the community. Telemedicine technology, ranging from clinical examinations by non-local clinicians via teleconferencing to consultation between school nurses and physicians via secure email, may have a role to play in these models of care. Using technology, schools can act as a hub for long term disease management, connecting schools with physicians and parents.

Disorders in the second pattern are defined by persistent characteristics that appear early in life, perhaps before the start of school, and tend to remain constant throughout childhood and adolescence. Although these conditions are likely to have an impact on schooling starting at this early age, intervention design should also take into account evidence that their ultimate impact on dropout may be through different pathways. Evidence is quite strong that children with ADHD suffer academic performance deficits starting in primary school (Duncan, Dowsett et al., 2007) and continuing through high school (Breslau, Miller et al., 2009). It is likely that the impact of ADHD on dropout has its origins in these early achievement deficits. If this is true, then interventions that identify children with ADHD in the early grades and provide academic support, in addition to existing clinical treatments which may include pharmacotherapy, may reduce dropout due in this group. The potential for reduction of ADHD symptoms to have a positive impact on achievement is supported by one longitudinal study, which found that children whose attention scores improved during the course of primary school also improved in academic achievement test scores between primary school and the end of high school (Breslau, Breslau et al. 2010).

Conduct disorder, which also begins early in life and is often comorbid with ADHD is likely to impact dropout through other means. The studies that have found academic deficits in children with ADHD have also found that after adjusting for ADHD, children with conduct disorder do NOT have lower achievement than other children (Duncan, Dowsett et al., 2007; Breslau, Miller et al., 2009). Rather than academic achievement or ability, the link between conduct disorder and dropout is likely to be the poor fit between children with conduct disorder

and the demands of the school environment. Concerns have also been raised regarding the negative impact of children with conduct disorder on the educational attainment of *other children*, for instance through the psychological effects of bullying. Designing interventions for this group of students is undoubtedly challenging, but future research might advance this goal by further identifying the pathway that leads them to drop out. For instance, conduct disorder might influence dropout from early grades or it may simply influence dropout through its influence on adolescent misbehavior. Research is needed to identify the relative contributions of childhood versus adolescent conduct problems to dropout.

The question of timing of interventions is one that should be considered for all the conditions in this group. Evidence is strongest for early intervention with ADHD and obesity. For these disorders there is evidence of early impacts on education that are very likely to have negative ramifications across the schooling career. However, the decision to drop out, which occurs in adolescence, may also be influenced by more proximal factors, and academic support provided in the later grades may be able to overcome earlier deficits. Moreover, these conditions may also affect the way that students and their family evaluate their educational options. For instance, students with conduct disorder may discount the value of future benefits of education. Interventions for this group might focus directly on how students weigh their alternatives as they make the decision to drop out or stay in school.

Students with conditions following the third pattern, such as smoking and pregnancy, are very likely to have already embarked on the path to dropout. Although associations between these conditions and subsequent dropout are in large part not a result of their causal effect, the finding that they are strongly related to underlying academic trajectories may provide an important insight that can direct development of intervention programs. Dropout prevention may not be able to address the underlying problem without addressing these conditions as well. For instance, a large amount of resources is devoted to smoking prevention and cessation programs for high school age adolescents. Most of these programs focus on delivering messages about the health consequences of smoking in terms thought to be most effective for adolescents. However, none of these programs addresses the underlying educational trajectory as a source of motivation for smoking initiation. The evidence reviewed here suggests that the links between smoking and educational achievement might be a more powerful target for intervention efforts.

There is an apparent paradox in that the best data from observational studies suggests only a modest impact of pregnancy on high school graduation, while intervention efforts that provide childcare services to girls who give birth in high school have demonstrated very strong positive effects. These findings might be explained by the strong association between pregnancy and poor academic trajectories, which are thought to be the underlying cause of dropout, and non-specific positive effects of interventions on academic performance. Girls who receive interventions are at high risk for dropout and respond positively to the intervention with respect to their academic performance. This is not altogether surprising since some interventions include

academic support. Other interventions are likely to impact girls' orientation to academics simply by providing additional mentoring by a concerned adult professional. The lesson from these studies, that academic performance can be improved through interventions targeted at high risk groups, might be applied to other conditions in this group.

The possibility of positive but non-specific effects of health interventions on academic success is also supported by a small evaluation literature on school-based clinics. The number of school-based clinics has grown consistently over the past several decades. These clinics provide a wide range of health services in a setting where all students have access to care and are thus well positioned to address complex health and educational problems (Kisker and Brown, 1996; Gall, Pagano et al., 2000). For instance, in a study of inner-city elementary schools in New York City, students with asthma missed fewer days of school if they attended a school with a school-based health center (Webber, Carpinello et al., 2003). A review of studies of school-based health centers found the evidence for positive effects on dropout and other educational outcomes inconclusive. Six of seven studies examined in the review reported some positive educational outcome associated with the presence of a school-based clinic in a school (Geierstanger, Amaral et al., 2004). However, the review also highlights methodological limitations of these studies, including non-random assignment to comparison groups, which limit the conclusions that can be drawn. School-based clinics are promising as settings for health interventions to reduce dropout, but more rigorous studies are needed.

The focus of this review has been on health conditions affecting school-age children and adolescents that might be targeted to improve their educational attainment. It is important to note that some other health conditions with potentially large effects on educational were not included, in particular health prior to age of school entry and parental health conditions. Among health problems prior to age of school entry, perinatal issues, such as low birthweight, have received the most attention. Poor perinatal health is associated with lower achievement and may account for intergenerational continuity in low educational attainment (Currie, 2009). Environmental exposures during the pre-school years, such as exposure to lead, have also been shown to have negative effects on intellectual function. Recent evidence suggests that lead exposures at levels previously thought to be innocuous may in fact have negative effects on school functioning (Chandramouli, Steer et al. 2009). Parental health may affect education in a number of ways. Mental disorders, such as depression, may limit the amount of educational support parents are able to give their children (Farahati, Marcotte et al., 2003). Other health conditions may constrain parents' ability to support children, place enormous financial burdens on families, or otherwise disrupt family stability. Secure access to health insurance would probably have the largest impact on reducing these effects.

Limitations of the literature

A number of important limitations to existing research should be noted. First, the optimal timing of intervention that will maximize the positive influence of academic attainment has not been directly addressed in health-related research. However, the three patterns described above provide some basis for some initial suggestions. For the first two patterns, evidence suggests that educational deficits may begin in the first years of schooling. Because the skills learned in the early grades are essential for successful learning of content in later years, early deficits may be more difficult to correct with later interventions. An important implication of this pattern is that detection of these problems should be based on early health screening rather than on educational evaluation; the optimal period for intervention may have already passed when these problems become detectable through educational evaluations. Optimal timing with respect to the third pattern is more difficult to discern because the problems occur at older ages and may be preceded by several years of educational problems. The temporal development of the association between low performance over the early years of schooling and risk behaviors has not been described in detail. If, as researchers have suggested, adolescent risk behaviors are motivated in part by students' self-perceptions of their own poor educational performance, then it is important to know when these initial negative experiences occur.

Second, the literature is not consistent in the assessment of educational outcomes, leading to difficulty comparing effects across studies and across conditions. This review focuses on high school dropout, the single most important educational milestone, but, as noted, studies which include high school dropout as an outcome have not been conducted for many health conditions. Moreover, high school dropout can be defined in a number of ways. For instance, studies may differ in whether or not a graduate equivalency diploma (GED) is counted as a successful high school graduation, although the benefits of graduating from high school on time do not accrue to students who receive a GED (Heckman and Rubinstein, 2001). The lack of assessment of high school dropout and other educational outcomes is notable in studies of pediatric health interventions.

In a recent editorial in the *Journal of the American Medical Association*, Robert Brook, a healthcare researcher at the Rand Corporation, argued that change in health care in the U.S. requires disruptions of traditional ways of doing things. Among these disruptions, he singles out the artificial barriers between medical and educational institutions, asking, "What if the practice of pediatrics included examining the report cards of children or performing an independent assessment of a preschool child's readiness to read?...What would happen if the same fundamental disruption occurred in the school system so that teachers were responsible not only for the educational achievement of students, but also for their health?" (Brook, 2009). The editorial reminds us that though health and education are closely related, medicine and education

remain distinct institutional realms, and that interventions that integrate health and education may be inherently disruptive on both sides of this divide. A continuing research focus on the interplay between specific health conditions, available treatments and ongoing educational trajectories is needed to build the models of care that can make this disruption a productive one.

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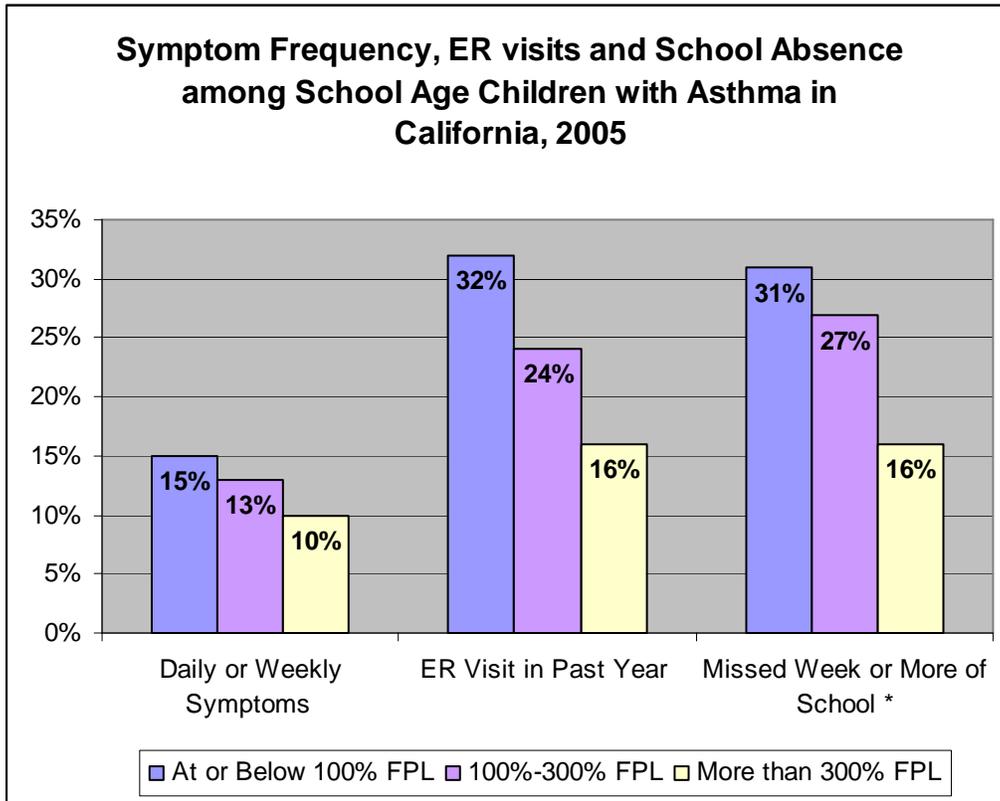
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Figure 1. Asthma contributes to school absence

Estimates based on the California Health Interview Survey suggest that the 900,000 school age children in California who suffered from asthma missed a total of 1.9 million days of school in 2005. This burden was disproportionately born by children in low income families.



* Children age 5-11.

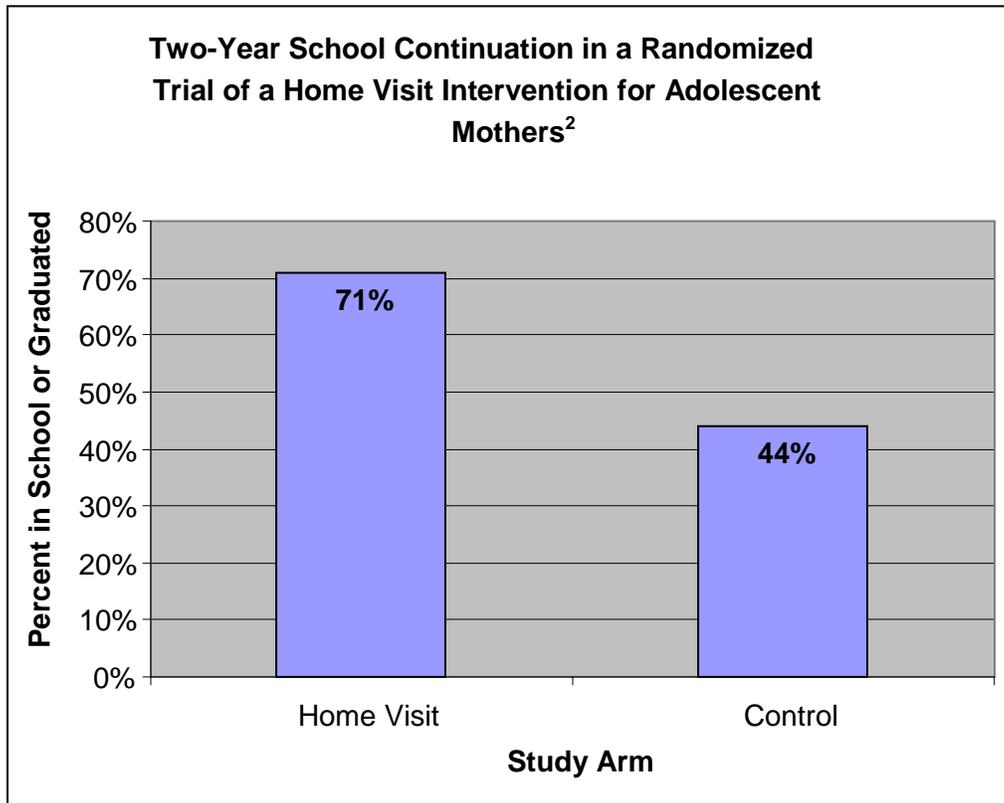
SOURCE: Babey SH, Hastert TA, Meng YY and Brown ER. *Low-Income Californians Bear Unequal Burden of Asthma*. Los Angeles: UCLA Center for Health Policy Research, 2007.

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Figure 2. Interventions can prevent school failure in at-risk adolescents

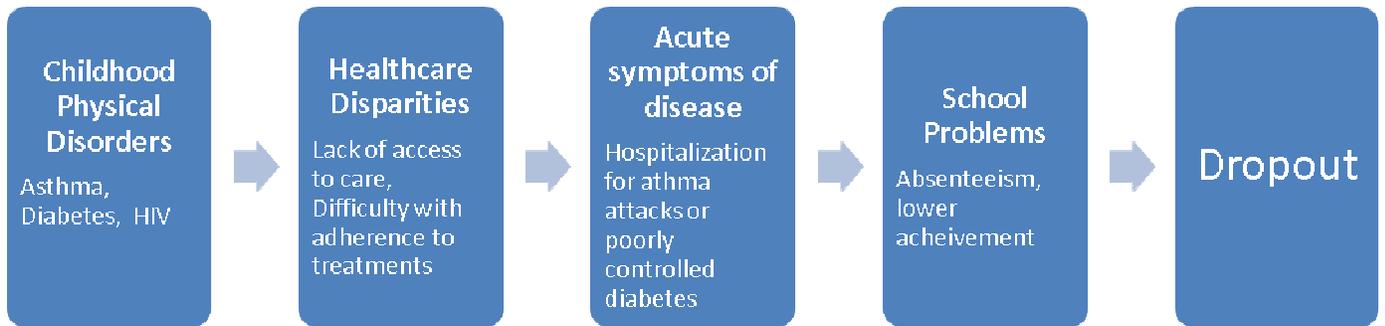
Only 40% of teen mothers in the US graduate from high school¹, but interventions that combine medical, social and educational support can improve educational outcomes.



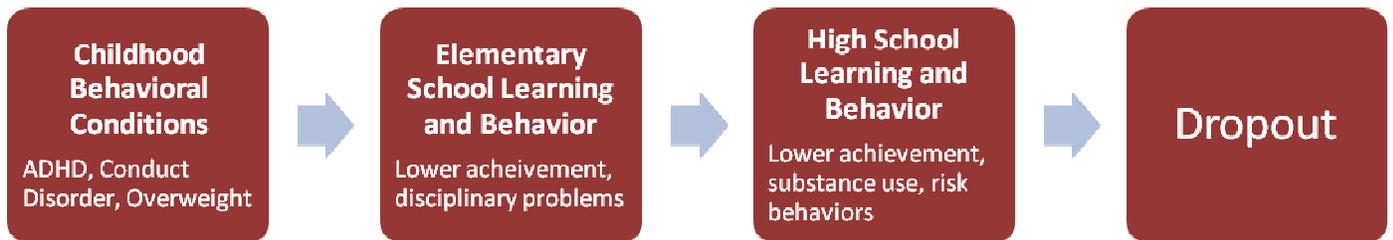
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Figure 3: Three Pathways from Poor Health to High School Dropout

A. Disparities in healthcare can allow treatable disorders to negatively impact schooling



B. Childhood conditions can directly affect learning and behavior



C. Poor academic performance can increase adolescent risk behavior

