Prev Sci (2009) 10:175–195
DOI 10.1007/s11121-009-0121-5

Educational Success and Adult Health: Findings from the Chicago Longitudinal Study

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Published online: 27 January 2009

Abstract Growing evidence indicates that education is associated with health, yet we lack knowledge about the specific educational experiences influencing health trajectories. This study examines the role school factors play in the emergence of poor young adult health outcomes for a low-income, minority sample. The following research questions are addressed. First, what are the education-based predictors of daily tobacco smoking, frequent substance use, depression, and no health insurance coverage? Second, do later-occurring school factors explain the association between earlier school measures and the outcomes and, if so, what pathways account for this mediation effect? Data were derived from the Chicago Longitudinal Study, an investigation of a cohort of 1,539 individuals, born around 1980, who attended kindergarten programs in the Chicago Public Schools. Participants were followed prospectively from early childhood through age 24, and study measures were created from various data sources and multiple assessment waves. Findings from probit hierarchical regressions with controls for early sociodemographic covariates indicated that elementary school socioemotional classroom adjustment and high school completion were significantly and negatively associated with all four study outcomes. Participation in the Chicago Child Parent Center preschool program predicted lower rates of both daily tobacco smoking and no health insurance coverage ($p<.05$). Middle school reading achievement was inversely related to depression ($p<.01$), while middle school frustration tolerance was inversely associated with daily tobacco smoking and frequent drug use ($p<.05$). Also, negatively linked to frequent drug use was a high school measure of students' expectation to attend college ($p<.01$). In nearly all cases, later-occurring school factors fully mediated significant associations between earlier ones and the outcomes. Patterns of mediation were explored along with implications of results.

Keywords Adult health · Education-related determinants of health · Early childhood education · Longitudinal panel data · Low-income minority sample · Adult behavioral health · Classroom adjustment · Chicago Longitudinal Study · Chicago Child Parent Center · Depression · Alcohol use drug use tobacco use · Health disparities · Education/health · Early childhood intervention · Socioemotional development · Health-related outcomes

Chicago Longitudinal Study grants from the National Institutes of Health (No. R01HD034294) and the Doris Duke Charitable Foundation (No. 20030035) supported the research reported herein. An Advanced Graduate Student Grant from the Interdisciplinary Training Program in Educational Sciences at the University of Wisconsin-Madison along with a Category A Research Grant from the Institute on Race and Ethnicity of the University of Wisconsin System provided additional funding for the completion of this study. Geetika Tiwari contributed to several study analyses.

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Introduction

In the past several decades, social science research has uncovered a robust and graded relation between socioeconomic status (SES) and health, such that SES has been

shown to relate positively to health outcomes not only across but also within the different strata of social and economic class. Subsequent work explored which of the three conventional components of SES (i.e., income, education, and occupation) drive the SES/health gradient (Adler and Ostrove 1999). Consistent with the goals of prevention science, these studies attempted to identify modifiable predictors of an unwanted outcome—health disparities. Although no one measure among those comprising the SES latent construct emerged as the sole determinant of adult health, educational attainment appeared to play a central role. For instance, in several studies when the primary measures of SES were tested simultaneously in prediction models, only educational attainment retained a significant association with health-related outcomes net of the influence of the other two (see Marsh and Hauser 2001; Winkleby et al. 1992). Although within different subgroups this finding changes, collective evidence suggests that education helps to promote physical and mental health and to alleviate health inequalities (e.g., Molla et al. 2004; Turrell et al. 2007).

Hammond (2002) and others posited three explanations to account for this observed education/health link: (1) individuals with better health are more likely to attain higher levels of education, (2) third variables (e.g., parental education level, family income) affect both educational attainment and health status, and (3) increases in educational attainment lead to improved health. In a test of all three, Hartog and Oosterbeek (1998) concluded that while there is empirical support for each, the strongest evidence rests with the third. To better understand this phenomenon, additional research examined subgroup effects. Such efforts found that although education exerts influence on health at all levels of family income and among all racial/ethnic groups, the education/health association may be most pronounced for low-income families and for people of color. For instance, Paschall et al. (2000) analyzed survey data from over 1,500 respondents and found that educational attainment related more directly to behavioral health outcomes in young adulthood for African Americans than for Whites. With data from an adult sample of nearly 20,000 participants, Luo and Waite (2005) found that educational attainment in part mediated the relation between childhood SES and adult health, especially for those from low-income childhood households. For poor minorities in this sample, however, the ability of educational attainment to ameliorate poor health outcomes was weaker compared to Whites from similar disadvantaged backgrounds. Factors such as social ordering, neighborhood influence and discrimination may underlie this finding (see Anderson and Armsted 1995). For poor racial minorities, education may impact health outcomes resulting in reduced health disparities, yet unique conditions facing this population may attenuate education's salubrious effect.

In sum, the relation between education and health appears to be significant across study samples and may be most marked among adults from low-income childhood households and from minority communities. Health, in this context, has been defined broadly to include adult self-reported health status and health-related behaviors. Education, on the other hand, has been operationalized primarily as educational attainment or school dropout. Knowledge about additional or more specific educational experiences that contribute to later health status and behaviors remains sparse. Hammond (2002) and Whalley (2006), therefore, call for a distillation of the education-based experiences and factors that contribute to positive health-related outcomes. They recognize the relative importance of education as a compensatory factor for populations at the lower end of the SES-health gradient. The virtue of education in this context lies in its potential alterability, its foundational role in life course development, and its precursory position to the other adult SES indicators.

For this current study, we tested hypothesized associations between an array of educationally-based predictors, from preschool through high school completion, and several young adult health outcomes. Two major research questions guided our analyses. *First, what are the education-based factors that predict the following young adult outcomes: daily tobacco smoking, frequent substance use, high depression scores, and no health insurance coverage?*[1] *Second, do later-occurring education-based factors mediate the association between earlier factors and these outcomes and, if so, what specific variables and pathways account for the observed relations?* Data were derived from the Chicago Longitudinal Study (CLS), a prospective examination of the life course development of a cohort of urban-dwelling, low-income minorities. Below we outline findings in the published literature evidencing an association between education (primarily educational attainment) and health-related outcomes corresponding to those of this study. We also cite work that ties these proximal health-related outcomes to ultimate outcomes. In so doing, we establish reasonable expectations for significant study

[1] The outcomes modeled in this study were meant to represent the domains of behavioral health, mental health and health care access, respectively. The authors did not analyze measures such as health status and chronic health problems given so few CLS respondents indicated they were in fair to poor health or had chronic health issues, resulting in highly skewed variables with little variance. Instead, we explored health-related outcomes more commonly experienced in young adulthood with demonstrated links to ultimate health concerns (e.g., Lleras-Muney, 2005). We also considered outcomes such as family problems, anxiety, and involvement in crime as potential dependent measures but rejected these based on issues of measurement or conceptual incongruity with health.

results and underscore the relevance of these potential findings for adult health and functioning.

Review of Literature

Tobacco Use

Education and tobacco use Studies examining the association between education and tobacco use reveal that educational attainment may represent the strongest correlate of tobacco use or cigarette smoking among such primary demographic features as gender, age, race/ethnicity, income, and occupation (e.g., Center for Disease Control and Prevention 2007; Steenland et al. 2002). A typical finding is that more highly educated adults relative to those with lower levels of education report less tobacco use or cigarette smoking in adulthood, while also realizing higher success rates in smoking cessation programs (e.g., Droomers et al. 2002).

Although the pathways to the initiation and maintenance of tobacco use are not very well understood, especially for children at-risk for outcomes such as delinquency and high school dropout, recent research has begun to shed light on early behavioral trajectories leading to cigarette smoking. For instance, Audrain-McGovern and colleagues (2004), utilizing a sample of 968 adolescent participants, investigated smoking trajectories for youth in grades 9–12. Overall, earlier/faster smoking adopters were characterized by poor academic performance. Further, based on a review of extant studies examining tobacco use consequences, Mathers et al. (2006) concluded that smoking may contribute independently to high school dropout net of such factors as delinquency and academic performance. Mechanisms explaining this observed relation may include neurological impacts of or deviant peer clustering around tobacco use. Further, it is well established that adolescent tobacco use predicts adult smoking (e.g., Moolchan et al. 2000); hence, the above findings in total suggest that the association between low educational attainment and adult tobacco use may be partly attributable to earlier school trajectories and adolescent tobacco use.

Tobacco use and adult health The relation between tobacco use and later serious health problems including premature death has been well-established (e.g., Bartecchi et al. 1994; Center for Disease Control 2007). For instance, cigarette smoking is implicated in a substantial portion of premature deaths due to cancer, cardiovascular disease, and chronic obstructive pulmonary disease (Center for Disease Control 2008). Urban-dwelling African Americans, in addition, demonstrate a "disproportionately" high rate of adverse health consequences from cigarette smoking, attributable in part to racial disparities in menthol cigarette usage and advertising trends (see Gardener 2004; Primack et al. 2007).

Substance Use

Education and substance use Previous research has demonstrated that the rate of adult substance use differs as a function of earlier school performance (e.g., Diego et al. 2003). In a longitudinal study of over 1,200 African Americans from the Chicago-area, Fothergill and Ensminger (2006) found that educational attainment related significantly to substance use problems. In a unique test of early school-based variables, the authors also found that first grade measures such as aggression, underachievement in school, and low school bonding were positively associated with the later substance use problems. In several additional study samples, substance use was consistently higher among high school dropouts versus high school completers for young adults ranging in age from 18–25 years (e.g., Substance Abuse and Mental Health Services Administration 1999; Droomers et al. 2004). While low educational attainment predicts adult substance use, substance use in adolescence appears to increase the chances of high school dropout (e.g., Townsend et al. 2007). In aggregate, these findings recommend consideration of earlier factors such as elementary school performance and adolescent substance use when examining and articulating the educational attainment/adult substance use connection.

Substance use and adult health Substance use or misuse has also been linked to poor adult health outcomes, including disease, accident and death. McGinnis and Foege (1999), for instance, highlighted the direct, causal link from the abusive or dependent use of illicit drugs to illness, injury and mortality. According to the authors, abusive or dependent use of addictive substances is the leading preventable cause of poor health among Americans over 15 years of age. Furthermore, substance misuse early in the life course; i.e., adolescence, aligns with poor health-related outcomes in later adulthood (e.g., Viner and Macfarlane 2005).

Depression

Education and depression While a large body of work has examined links between education and health, research exploring the association between educational experiences and mental health is sparse, especially with adult samples.

Some evidence exists, however, that corroborates an association between low educational attainment and depression-related outcomes. For instance, Masten and Curtis (2000) found that social and cognitive factors in early childhood predicted later psychopathology. Extant evidence also suggests that perceived academic failure leads to greater internalizing problems (Masten et al. 2005) and consequently predicts increases in depressive symptoms (Cole et al. 1997). In a comprehensive review of published studies, Gallo and Matthews (2003) concluded that the majority of evidence supported the hypothesized connection between SES/education and depression. Namely, low levels of SES and educational attainment appeared to increase the risk for depressive symptoms or disorders in adulthood. More recently, Koster et al. (2006), with panel data from over 2,500 participants, found that educational attainment predicted depression in adults.

Depression in childhood or adolescence might also contribute to low educational attainment. Fletcher (2008) relied on unique prospectively collected data to test the relation between adolescent depression and educational attainment. This data showed that depression impacted measures such as high school dropout for females but not for males. This is, according to the author, a common finding in the literature. It introduces some caution in interpreting the educational attainment on depression findings, suggesting that inclusion of adolescent depression and possibly earlier education-based measures would add confidence and insight to results.

Depression and adult health Depression or depressive symptoms can, in turn, increase the probability of developing later health and medical problems (e.g., Bardone et al. 1998). For instance, recent research in the medical and social sciences has detected an association between mental states and physical health (e.g., Salovey et al. 2000). Specifically, depression appears to affect health and health markers through a variety of biosocial mechanisms such as social support, immune functioning, and the autonomic nervous system (e.g., Kosslyn et al. 2002). Summarizing this research, Gallo and Matthews (2003) found evidence implicating depression in cardiac-related morbidity and mortality. Weaker albeit compelling results linked depression to "all cause mortality" and stroke.

Health Insurance

Education and health insurance Little research exists on early educational and behavioral predictors of health insurance coverage. Among adults in the U.S., however, the likelihood of being insured increases with higher levels of education (Mills and Bhandari 2003). Earning a high school diploma appears to be an important predictor of insurance status (see Nelson 2003). Individuals with diplomas are twice as likely to be covered by some form of health insurance when compared to those without a diploma (Institute of Medicine of the National Academies 2001).

Health insurance and adult health As the number of uninsured adults has risen in the U.S., interest in the health consequences of having no health insurance coverage has grown. A relatively recent line of research suggests that health insurance coverage, private or public, confers health benefits to recipients relative to no coverage. A number of factors may explain this phenomenon, including better access to and utilization of health care (see Dorn 2008). To illustrate, Fowler-Brown and colleagues (2007), tapping prospective data for a sample of over 15,000 adults, showed that uninsured adults had a greater probability of stroke and death versus insured adults. No health insurance coverage was also associated with lower self-reported rates of attendance at routine physicals and greater inability to control high blood pressure. In addition, Hadley (2007) studied over 15,000 individuals who experienced a recent "health shock" based on injury or chronic illness onset. Results indicated that persons without health insurance coverage were less likely to receive medical care and more likely to report poor health outcomes subsequent to the initial "health shock" compared to those with coverage. Finally, it appears that both adults and children with public health insurance coverage enjoy health advantages over those with no coverage (e.g., Buchmueller et al. 2005) although studies investigating this issue produce complex results. For instance, Currie, Decker, and Lin (2008) revealed that public health insurance coverage for a sample of adolescents improved access to preventive care but affected health outcomes only if provided early in the life course. In addition, Quesnel-Vallée (2004) revealed that no health insurance coverage from approximately ages 28–39 was significantly and negatively associated with self-reported general health status at ages 40–44. Furthermore, the relation of public health insurance to this outcome did not differ significantly from that of private health insurance. Although a trend-level difference favored private health insurance over public health insurance, the author concluded that public insurance provided a significant self-reported health benefit over no insurance. In sum, empirical results are illuminating health risks associated with not having health insurance and, conversely, health benefits related to carrying either public or private health insurance.

Current Study

Contributions of the Current Study

This study makes five unique contributions. First, sample members are at greater risk relative to the general population for experiencing health difficulties in adulthood given their SES and minority status. Although the relative homogeneity of the sample limits generalizability, it conversely helps isolate the relation between education and health at this socioeconomic level. As mentioned above, previous research identified a stronger effect of education on health at this stratum (e.g., Schnittker 2004), yet minority status tends to attenuate this effect. Inquiry into the specific experiences that predict or prevent poor health outcomes for this vulnerable sample appears warranted.

Second, literature examining the education/health relation generally defines the former somewhat broadly, either subsuming it under a latent SES construct (see Oakes and Rossi 2003) or identifying it with a single indicator of educational attainment (see Groot and van den Brink 2004). Instead, we focus solely on education-related predictors while controlling for other SES markers, and we model educational experiences with a range of measures including participation in high quality preschool and school-age programming, classroom adjustment, academic achievement, college expectation, and high school completion. Third, we examine the effects of later-occurring, education-based measures on earlier ones, conducting exploratory path analyses when indicated. We are aware of only one other study that investigates, at such specificity, the effects of a number of education-related experiences on health-related outcomes in a low-income, minority sample (Fothergill and Ensminger 2006). This current study, however, expands on this previous work by utilizing additional waves of data collection throughout childhood and adolescence and by examining health-related outcomes beyond substance abuse. Fourth, an additional contribution of this study is its inclusion of an early adult depression measure as a response variable to education-related experiences. Examining an indicator of depression in this way provides insight into the little studied relation between education and later mental health.

Fifth, we expand on prior work demonstrating links between preschool interventions and adult health. Four longitudinal evaluations of early education interventions assessed long-term program impacts on adult health outcomes. Studies found each preschool program to have a significant main effect association with select adult health markers. For instance, Palfrey et al. (2005) in a 25-year follow-up study of young adult past participants of the Brookline Early Education Project (BEEP) discovered that the urban-dwelling program group reported higher rates of private health insurance coverage, better overall health, stronger "health efficacy," greater number of health behaviors, and less depression than its comparison group. BEEP targeted "health and developmental" functions, arguably explaining its success in linking to a broad range of health outcomes. The Abecedarian Project, a panel study of the effects of an early childhood education program within a child care setting, conducted an age 21 wave of self-report assessments. Analyses from these data revealed that participation in this program serving low-income, primarily African American infants, protected against marijuana use and depressive symptoms (Campbell et al. 2002; McLaughlin et al. 2007). A high quality preschool pilot program, High-Scope Perry Preschool, was associated with a reduction in drug-use among its participants at age 40 (Schweinhart et al. 2005). Finally, the CLS examined the long-term, health-related correlates of participation in the Chicago Child Parent Center (CPC) preschool program, a large-scale center-based intervention. Ages 22–24 follow-up data revealed that program participation was associated with health insurance coverage and self-reported depressive symptoms (Reynolds et al. 2007). This current study builds on these CLS analyses by expanding the health-related outcomes[2], exploring multiple school-based predictors of health beyond CPC preschool program participation, and conducting exploratory mediation analyses when indicated.

Method

The CLS is an ongoing panel study of 1,539 low-income, minority children who completed government-funded kindergarten programs in the Chicago Public Schools in 1986. The study's primary goals include chronicling the school

[2] Outcomes examined in this current study are relevant young adult indicators of poor health trajectories for two reasons. First, as mentioned above, they presage health concerns that often do not appear until middle to late adulthood. Second, they represent distinct, albeit related, domains of functionality. For instance, while the association between depression and substance use is well accepted (e.g., Brady & Sinha, 2005), the correspondence is not extremely high, the causal direction varies, and the relation is nuanced (see Green & Ritter, 2000; Murphy et al, 2003). Likewise, depression symptoms or depression itself appear to heighten the risk for addictive use of tobacco; however, it does not act as a primary predictor of smoking initiation (e.g., Leff et al., 2003). Additionally, the majority of adult smokers do not have depression or significant depressive symptomology (Murphy et al., 2003). The outcomes examined in this current study, therefore, describe different although overlapping subgroups of young adults who are vulnerable to poor health by virtue of their current and distinct health risks. Indeed, our measures of tobacco/substance use, depression, and no health insurance coverage share at most 4% variance.

progress and psychosocial development of sample members through school-age years and beyond and assessing the effects of the CPC program.

Chicago Child Parent Center Program

The CPC program was established in 1967 as part of a nationwide, federally-funded effort to enhance the school performance of disadvantaged children. During the mid-1980s, when CLS sample members participated in the CPC program, 20 CPC preschool sites operated in high poverty areas that lacked Project Head Start or other early childhood services. The program included preschool, kindergarten and school-age components. The preschool component ran 1 to 2 years in length and provided half-day programming each weekday. CPC kindergarten classes varied from half to full day in duration, and the school-age component, administered in grades 1–3, followed a typical full day school schedule. All CPC classrooms operated throughout the traditional 9-month academic calendar. Program principles emphasized language skill acquisition, active student learning, classroom parental involvement, and small class size. Organizational structure, teaching curriculum, room layouts and building locations supported these principles and distinguished CPC classrooms. For instance, CPC instructors regularly integrated field trips into the routine of learning, incorporated parents in classroom activities, and claimed a student to staff ratio of 8:1. To support student success and family functioning, the program also offered nutritional and health services to students on-site along with referral and outreach services to parents both on-site and in the home. The program also employed credentialed teachers, offered in-service training for professional development, and remunerated staff commensurate with comparable elementary school roles. Last, process evaluations found that the CPC program, throughout all sites, was implemented with a high degree of program fidelity (Reynolds 2000).

The preschool/kindergarten and school-age program components shared a common philosophy but differed somewhat in structure. For instance, the preschool and kindergarten classes were conducted in CPC centers proximal to but separate from primary school buildings, whereas the primary school program was delivered within elementary schools. Also, relative to the school-age program, more support staff were dedicated to the implementation of the preschool/kindergarten program per site. In fact, the CPC program originated solely as a preschool/kindergarten project and after ten years of operation introduced the school-age component as a follow-on service.

An ecological-transactional model of development (Lynch and Cicchetti 1998) informed our interpretation of potential CPC program effects. Theoretically, we hypothesized that program participation will enhance parental investment in the child, parental functioning, and parent-school partnership. Simultaneously, the child's engagement in developmentally enriching school activities will facilitate cognitive growth, social adjustment and school commitment. This in turn will reward and strengthen parental attachment to and investment in the child and her scholastic progress, which will enrich child development. Ultimately, these reinforcing effects will cascade into social/emotional maturity, motivational advantage and academic achievement for the child, culminating in adult stability and well being. When specifying prediction models for current study analyses, we draw upon this theoretical orientation.

Sample and Design

The CLS began prospectively collecting data on a CPC preschool intervention group (n=989) and a preschool comparison sample (n=550) in the mid-1980s, the time at which the preschool group was completing kindergarten. For a diagrammatic depiction of the sample members' pattern of program participation, see Appendix A. The experimental or intervention group represents all children who enrolled in the CPC preschool program in the fall of 1983 or 1984 and graduated from CPC kindergarten in 1986 with at least 1 year of preschool. Fourteen CPC sites offered CPC preschool and half day CPC kindergarten programming while 6 CPC sites offered CPC preschool and full-day CPC kindergarten programming. Eligibility for voluntary CPC program participation was based on neighborhood poverty and residence in 1 of the 20 CPC preschool center school areas. In this study, all CPC preschool participants attended CPC kindergarten. Not all CPC kindergarten attendees, however, participated in CPC preschool, as discussed below. For this reason, and because CPC kindergarten programs varied in duration from half day to full day, we did not consider CPC kindergarten participation when constructing program variables. This decision, if it does affect evaluation results, would lead to conservative estimates of the program's impacts.

From a pool of 27 area schools participating in the Chicago Effective Schools Project, 5 schools were randomly selected to create the CPC preschool comparison group. The Chicago Effective Schools Project targeted racially segregated, low achieving schools in high-poverty neighborhoods with supportive funding streams and services. All students who enrolled in this project's all day kindergarten in one of the five randomly selected project schools during the 1985–1986 school year (n=374) were included in the comparison group. Eighty-five of these students attended a Head Start Preschool program prior to

kindergarten attendance. Another group of children (n=176) who attended a CPC kindergarten site in 1985–86 but did not attend CPC preschool was also included in the preschool comparison group.

Given eligibility requirements for participation in CPC and Chicago Effective Schools Project programs, children from both school areas were expected to match on important demographic features, and indeed the CPC preschool and comparison groups were comparable on factors such as race, free lunch eligibility, neighborhood poverty, parent employment status, and single parent household. These groups differed significantly, however, on average number of children in the families and on mean parent educational level. The former difference favored the comparison group while the latter advantaged the intervention group (Reynolds et al. 1998). Selection bias may have challenged group comparability in this quasi-experimental sampling design; however, extensive CPC staff recruitment of neighborhood families for preschool participation limited self-selection. Additionally, an array of data on demographic characteristics provided statistical controls for self-selection and other internal validity threats (Reynolds et al. 2001). Utilizing this data, Reynolds and Temple (1995) conducted analyses to test prediction models of program participation. Findings supported the hypothesis that residential proximity to CPC centers rather than parental incentive motivated program participation.

Due to the natural environment in which this study took place, a set of different comparison and experimental groups emerged for the CPC school-age intervention. This program component covered grades 1–3 with aims of easing transition to primary school grades and reinforcing gains realized in preschool/kindergarten years. Students could participate anywhere from 0 to 3 years and many of those who attended CPC preschool also participated in this follow-on program for varying lengths of time (n=684). While a substantial number of preschool sample members left the CPC program after kindergarten (n=305), a portion of students from the preschool comparison group entered a CPC primary school program (n=166). These were students who enrolled in CPC kindergarten with no prior preschool participation and then continued in the CPC program or were students who attended a Chicago Effective Schools Project school that offered the CPC school-age program[3]. Last, a number of children (n=384) who did not attend the preschool program also did not attend the school-age program based primarily on program availability.

[3] Two of the five Chicago Effective Schools Project sites randomly chosen for the comparison group offered CPC school-age but not CPC preschool programming.

Data Collection

The CLS collected data on study participants for ages 3–24 through multiple sources such as administrative records, parent and teacher interviews, and student self-report. Data reflecting life circumstances of children prior to study involvement; i.e., ages 0–3, derived from administrative clearinghouses such as the Chapin Hall Center for Children, and were retrospectively supplemented with parental self-reports. This information informed the study covariates. Additionally, the CLS culled information from teacher reports and school records to create the education-based measures of this study. Finally, the majority of the outcome data emerged from participant interviews, completed from 2002–2004, when study members were ages 22–24. Intensive tracking efforts yielded 1,142 completed interviews, representing a 76.3% recovery rate of eligible cases (ineligibility was due to death). The tobacco smoking, substance use, and depression samples, informed solely by the adult survey, varied slightly according to valid data. The health insurance measure incorporated adult survey and administrative data resulting in a sample size of 1,277. See Table 1 for descriptive statistics of the study's predictor and outcome measures along with their intercorrelations.

The adult survey sample was comparable to its attrition sample in several of the ages 0–3 factors including low birth weight, child welfare history, and maternal employment (see Table 2). The two samples differed significantly, however, in their gender and race composition as well as in rates of individual risk factors such as mother's educational attainment and public aid receipt. The attrition group was generally more disadvantaged, and although both groups produced comparable mean risk index scores, selective attrition reinforced the need to control for gender and race. The health insurance study and attrition samples varied significantly on gender composition, low birth weight rates, and several individual risk factors. Propensity scoring procedures enabled us to construct variables indicating predicted probability of inclusion in study samples. To test the robustness of results to sample attrition, we entered these propensity scores into secondary predictor regression models.

Measures

Outcome Measures

Daily tobacco smoking A measure of daily tobacco smoking came directly from the adult survey. Respondents were asked have they ever smoked tobacco, and if yes, how often do they currently do so. We treated all cases endorsing use of one or more cigarettes per day, 20.1% of the study sample, as daily smokers and assigned them a

Table 1 Correlation matrix and descriptive statistics for explanatory variables and adult health-related outcomes[a]

Variable	1	2	3	4	5	6	7	8	9	10	11
1. CPC preschool program, any	1										
2. CPC school-age program, years	.297*	1									
3. Socioemotional classroom adjust.	.084*	.094*	1								
4. Frustration tolerance (grades 6-7)	.051*	−.015	.481*	1							
5. Reading achievement (grade 8)	.129*	.111*	.574*	.331*	1						
6. College attendance expectation (grade 10)	.026	.027	.202*	.120*	.200*	1					
7. High school completion	.116*	.032	.298*	.218*	.302*	.246*	1				
8. Daily tobacco smoking	−.066*	−.033	−.147*	−.122*	−.124*	−.105*	−.225*	1			
9. Frequent substance use	−.014	−.015	−.135*	−.127*	−.090*	−.167*	−.195*	.292*	1		
10. Depression scale, top quartile	−.026	−.003	−.096*	−.060*	−.118*	−.078*	−.159*	.184*.	153*	1	
11. No health insurance coverage	−.090*	.004	−.148*	−.110*	−.114*	−.102*	−.153	.128*	.207*	.131*	1
*p<.05											
Mean	0.657	1.210	19.126	14.536	145.924	0.641	0.641	0.201	0.126	0.243	0.338
(SD)	(0.475)	(1.181)	(4.470)	(3.927)	(21.270)	(0.480)	(0.480)	(0.401)	(0.332)	(0.429)	(0.473)
Range	0–1	0–3	7–30	5–25	79–212	0–1	0–1	0–1	0–1	0–1	0–1

[a] All statistics based on adult survey sample (N=1,142), except those specific to the no health insurance coverage measure and sample (N=1,277).

code of 1. Cases selecting any other categories, almost everyday or less, were assigned a code of 0.

Frequent substance use Also from the adult survey, we created a dichotomous substance use measure indicating use of marijuana or drugs harder than marijuana a few times per week or more. Of study members, 12.7% acknowledged such patterns and were coded 1 on this outcome. Frequent use of illicit substances in adulthood, although not a direct indicator of abusive or addictive use, does correlate with

Table 2 Unadjusted mean rate comparisons between CLS Full sample, Current study samples, and Attrition samples

			Sample Rates for Adult Survey Only		Sample Rates for Adult Survey & Insurance Data	
Variable Description	*N*	Total Sample Mean Rate	In (N=1,142)	Out (N=397)	In (N=1,277)	Out (N=262)
Gender, 1 = female	1,531	50.2	54.3	38.0*	54.7	27.2*
Race code, 1 = African American	1,539	93.0	94.1	89.7*	93.3	91.2
Low birth weight, < 2,500 g	1,539	11.8	12.0	11.1	12.5	8.4*
Child welfare history, ages 0–3	1,539	3.8	3.6	4.3	3.8	3.8
Risk Index, measured at ages 0–3 (items below)	1,539	3.6	3.5	3.7	3.6	3.6
-40% or > poverty in census tract area	1,539	45.9	45.7	46.4	46.1	44.7
-Single parent household	1,539	76.5	75.0	80.6*	75.9	79.4*
-Mother ever a teen parent, < 18	1,539	35.5	36.5	32.5*	36.5	30.5*
-Mother did not complete high school	1,539	54.3	52.5	59.2*	54.0	55.7
-4 or more children living in household	1,539	16.6	17.6	13.9*	17.4	13.0
-TANF/AFDC participation	1,539	62.8	61.1	67.5*	61.8	67.6
-Mother not employed full- or part-time	1,539	66.3	65.6	68.5	65.9	68.3

*Statistically significant group difference
p < .05, [a] Range 0–7, means listed are not in percentages or rates

substance dependence and health risks (e.g., Chen et al. 1997; Fullilove et al. 1999).

Depression The depression outcome was derived from five adult survey items appearing in a modified version of the Derogatis Brief Symptom Inventory depression subscale (see Derogatis et al. 1976). Each item assessed how often one feels a manifestation of depression within the past month, 0 meaning "not at all" to 5 meaning "almost every day." The items included feeling depressed, feeling hopeless, feeling lonely, feeling life isn't worth living, and feeling very sad. Cronbach's alpha reliability coefficient for these five items was .84. Summing the items into a scale produced a highly skewed, hard to interpret continuous variable. We, therefore, created a primary dichotomous outcome measure using the cut point of six or above to approximate the top quartile of the depression scale scores.

No health insurance coverage We created a dichotomous measure of no health insurance coverage from two adult survey questions, (1) Are you covered by any kind of health care? and (2) Do you get health benefits from your current employer? We augmented this self-report data with two administrative sources, (1) state-level Medicaid records to identify additional cases with public health insurance coverage, and (2) Illinois Department of Employment Security records to identify additional cases with private coverage. This resulted in a sample size of 1,277 and a rate of no health insurance coverage equaling 33.8%, slightly exceeding national averages from 2001–2004 for 18–24 year olds (National Center for Health Statistics 2004).

As cited previously in this paper, prior empirical evidence provided support for combining private and public health insurance (e.g., Quesnel–Vallee 2004). Additionally, bivariate analyses of CLS data revealed that private and public health insurance measures were both significantly and negatively correlated with indicators of health risk behavior; conversely, our measure of no health insurance coverage was significantly and *positively* correlated with these outcomes.

Education-Based Predictors

CPC program participation We created two measures of CPC program participation from Chicago Public School records. The first, preschool participation, identified children who enrolled at ages 3 or 4 in the CPC preschool program and graduated from CPC kindergarten in the spring of 1986. Previous dosage response studies found that the number of years of preschool program participation, one versus two, predicted only one of many outcomes proximal to program participation. For that reason we treated the preschool participation variable as a dichotomy, highlighting any preschool program participation versus none (Reynolds 2000). The second CPC program variable, school-age program participation, indexed the number of years sample children participated in the grades 1–3 CPC program, ranging from 0–3. We characterized this variable as continuous given that years of extended program participation linked to social adjustment outcomes in previous studies.[4]

Socioemotional classroom adjustment A measure of grades 3–6 socioemotional classroom adjustment stemmed from a unique teacher-rated scale completed at the end of each elementary school year. For each student, teachers assigned scores from 1 (poor) to 5 (excellent) on the following six items: concentration, ability to follow directions, self-confidence, participation in group discussions, interactions with others, and self-responsibility. Scale scores for the CLS sample from third through sixth grade produced internal reliability coefficients from .89 to .91 (Chicago Longitudinal Study 1999). Also, previously published studies from the CLS found this scale of students' classroom adjustment to have significant predictive validity for important adolescent outcomes (e.g., Mann and Reynolds 2006). To create the study measure, we averaged scores from third through sixth grades. For cases missing valid data in one or two of the considered grades, we computed the average of remaining scores, and for cases with only one valid score (12% of total)[5], we treated this value as the grades 3-6 average. For cases with no valid data (9.5% of total), in the LISREL 8.71 processor, we estimated missing values with a multiple imputation strategy using an expectation-maximization (EM) algorithm (Schafer 1997). This strategy draws on known associations between the measure in question and alternative study variables to generate an imputed value. We applied this technique when missing values could not be inferred from alternative grade values of the same instrument.

Frustration tolerance We created a later social adjustment measure (grades 6–7) from a subscale of the Teacher-Child

[4] We did not aggregate years of CPC program participation in this study, from 0-6, for several reasons. First, the preschool program and school-age program are, as discussed in the text, structurally different. Also, previous CPC studies highlight the relative potency and uniqueness of the preschool program given the high quality, tailored services it delivers and the sensitive period of development it targets. Although the preschool and school-age program variables are relatively highly correlated, there is variability in program participation, which is amplified when the school-age participation measure is treated as a continuous variable.

[5] Total refers to the adult survey sample, N=1,142. We do not show missing data percentages based on the insurance sample due to space limitations and our primary reliance on the adult survey sample; i.e., three of four outcomes modeled in this study use this sample.

Rating Scale (T-CRS). This subscale, conceptualized as an indicator of frustration tolerance, consists of the following five items: accepts things not going his/her way, ignores teasing, accepts imposed limits, copes well with failure, and tolerates frustration. Teachers rated how well students manifested these attributes of social and emotional maturity from 1 (not at all) to 5 (very well). Internal reliability coefficients associated with these 6th and 7th grade subscales in the CLS were .92 and .91, respectively. Perkins and Hightower (2002) demonstrated that the T-CRS typically generates high reliability coefficients along with good construct validity properties as an indicator of adolescent adjustment. To arrive at a single measure of frustration tolerance for this current study, we averaged subscale scores for both grades 6 and 7 while relying on scores for either if only one existed. For those with missing data in both grades (29% of cases), we employed the EM multiple imputation strategy.

Reading Achievement A reading score from the ITBS grade 8 reading comprehension subtest reflected academic achievement in middle school. This widely implemented subtest has a Kuder-Richardson reliability coefficient of .92 using 1988 national norms (Reynolds 2000, p. 75). Throughout the Chicago Public School system, it was administered in the spring of 1994 to 8th graders when most CLS participants were 14 years old. Of the 1,142 study sample cases, CLS had valid data on 1,029 cases for this measure. For a relatively small number of cases with missing data on this measure (6.7% of total), we estimated the grade 8 reading scores based on ITBS reading scores of other grades. High correlations of scores across grade levels and a missing value estimation formula consistent with the scoring structure of the test enabled this strategy (Reynolds et al. 2004)[6]. For cases with no ITBS scores from temporally proximal grades (3.2% of total), we imputed data using the EM algorithm.

College attendance expectation In a 10th grade survey, students reported whether or not they expected to attend college. The CLS supplemented this survey data with 4th and 12th grade student responses to a similar question to create a dichotomous measure of college attendance expectation. We treated remaining cases with missing data (22.8% of total) with the same multiple imputation strategy as above.

Educational attainment High school completion by September of 2001 represented our educational attainment indicator. Completers graduated from high school or earned General Education Degrees. Administrative data from all high schools that youths attended, family interview data and adult survey data informed this measure.

Covariates

Sex and race/ethnicity of child School records indicated sex and race/ethnicity of the students. Girls were coded 1 and boys were coded 0. African American students, 94.1% of the sample, were coded 1 and Hispanic students, the remaining 5.9% of sample members, were coded 0.

Low birth weight and child welfare history Sample members born at a weight below 2,500 g were coded 1 on this variable versus 0 for all others. The Illinois Department of Public Health provided these data. Children with any family-level history of child welfare service receipt ages 0–3 (n=41) were coded 1 on a measure of child welfare history while all others were coded 0. Child welfare agencies, unlike traditional welfare programs, provide services for children who are at-risk for or have experienced child maltreatment. The CLS obtained child welfare-related data from Cook County Juvenile Court along with Cook County Department of Child and Family Services through a data base at the Chapin Hall Center for Children. We considered this child welfare history measure a proxy for child maltreatment, which has been linked to early and later educational performance (e.g., Shonk and Cicchetti 2001) and to adult health (e.g., Corso et al. 2008).

Risk index The CLS created seven dichotomously coded environmental risk factors measured at or around birth: (a) residence in high-poverty neighborhood (40% or more of households below the poverty level according to 1980 census tract data), (b) single-parent household, (c) mother ever a teen parent, (d) mother did not complete high school, (e) four or more children living in family household, (f) family participation in the public assistance programs Temporary Assistance to Needy Families or Aid to Families with Dependent Children, and (g) mother not employed full or part-time. A code of 1 indicated high-risk status on each item, and all risk variables were summed into a 7-item cumulative risk index, ranging from 0–7. School records of family residence along with census tract data informed the neighborhood poverty item; data from the Illinois Department of Human Services

[6] To calculate this estimated value, we identified the available test score most proximal in time to 8th grade and added to it the overall sample's average incremental change in test score from that grade to the 8th grade. To arrive at an estimated 8th grade score from a known 9th grade score, the average score change was subtracted from the known value; i.e., the 9th grade score. This procedure is based on the scoring structure of the reading subtests, which "have equal-interval scale points and index continuous development over the grade year." (Reynolds, 2000, p. 73).

informed the public aid measure; and birth records from the Illinois Department of Public Health along with parent reports informed the remaining family measures. We treated missing data with the multiple imputation strategy as above. To control for the effects of missing data, we created a dichotomous measure denoting cases missing values on any of the seven risk items (13.9% of the sample) and entered this covariate into models testing robustness of primary analysis results.

Data Analysis

CPC program theory along with an ecological transactional model of development guided initial variable choice. The CPC interventions targeted cognitive, social, family and motivational functioning of participants. Therefore, in initial exploratory regression analyses, we examined post-CPC program variables representing these developmental domains. Nearly all measures spanned grades 3–6, related in some way to school performance, and included the following: reading achievement scores, socioemotional classroom adjustment, parent involvement in school, and student commitment to school. We also tested the impact of a kindergarten word analysis measure given preschool program theory predicted intervention effects through the mechanism of early cognitive advantage. Analyses revealed that only the social adjustment variable produced stable and interpretable parameter estimates across prediction models of the study outcomes. We, therefore, retained this measure as our sole education-based predictor of health from grades 3–6.

For our middle/high school predictors, we chose measures from the domains of academic achievement, social adjustment, motivational advantage and educational attainment given the primacy of these for adolescent development. Grade 8 reading achievement, versus grade point average or math achievement, emerged as our indicator of middle school academic performance given its reliability and predictive validity (see Reynolds 2000). We selected frustration tolerance to represent the social adjustment domain due to its conceptual congruence with, yet temporal distinction from, our elementary school socioemotional measure[7]. College attendance expectation was included as an indicator of motivational advantage in later years. It is germane to theory and behaved consistently across initial analyses. The last predictor selected, high school completion, functioned as our traditional education attainment measure. Previously published CLS studies provided empirical and theoretical support for choosing this measure over high school graduation (e.g., Ou and Reynolds 2008).

Table 1, displaying unadjusted Pearson correlations and Kendall's tau coefficients, indicates that nearly each predictor correlates significantly and in the expected direction with each outcome. To further probe relations of interest and to address question one of this study, we employed probit regression analyses with Stata8 software. Like logit, probit is a binary response model estimated by maximum likelihood methods but "has good properties in large samples" (Horowitz and Savin 2001, p. 45). One advantage of estimating probit models is the generation of marginal effects coefficients associated with each predictor. These highly interpretable parameter estimates reflect the percentage change in the outcome variable corresponding to a 1-unit change in the predictor.

For each outcome we ran a series of hierarchical regressions, introducing predictors in temporally sequenced, cumulative steps. We started with a base model in which we regressed the outcome in question on the five study covariates along with the CPC preschool program variable. In the next step, resulting in model 2, we added the CPC school-age program variable to the previous prediction model. For model 3, we entered the grades 3–6 socioemotional classroom adjustment measure. In the fourth model, we introduced three predictors from the middle/high school block: frustration tolerance, reading achievement, and college attendance expectation. Finally, for the last model, we included high school completion. We tested results from two sets of alternative models. For one we included the propensity score variable in all regressions and for another we had the missing risk variable in all models.

To better understand these models in keeping with research question two, we identified results from question one that suggested mediation of early school-related variables by later ones. Once mediation was established, we undertook block recursive, temporally sequenced analyses through traditional path modeling. To estimate path coefficients we employed both ordinary linear and probit regression tests, contingent on the nature of the outcome examined. Spostada software (see Long 1997) generated fully standardized coefficients for both regression strategies facilitating comparisons of path coefficients throughout the mediation models.

Results

Question 1

Tables 3, 4, 5 and 6 display probit regression output for five identical, hierarchically-constructed models predicting each

[7] We considered the acting out subscale of the T-CRS over frustration tolerance, but the latter was more gender neutral and consistent with other predictor measures in directionality. School mobility was also considered for inclusion in the middle/high school block of predictors but was rejected because it implied family circumstance rather than student-school interface.

Table 3 Marginal effects of hierarchical probit models predicting daily tobacco smoking (N=1,125)[a]

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5
CPC program participation					
CPC preschool	−.050*	−.046	−.038	−.034	−.023
CPC school-age (grades 1-3)		−.005	.000	−.002	−.004
Elementary school classroom adjustment					
Socioemotional classroom adjust. (grades 3–6)			−.013**	−.008*	−.005
Middle/high school adjustment & achievement					
Frustration tolerance (grades 6–7)				−.009*	−.008*
Reading achievement (grade 8)				.000	.000
College attendance expectation (grade 10)				−.049	−.028
Educational attainment					
High school completion (by Sept. 2001)					−.129**
Pseudo R^2	2.85%	2.87%	4.68%	5.54%	7.51%

*p<.05 **p<.01 [a] Models adjusted for the following covariates: sex, race, early child welfare history, low birth weight, and 7-item risk index.

of our four study outcomes. Numbers associated with predictors are marginal effects calculated with all measures centered at the model mean. Pseudo R^2 coefficients are included[8]. For the daily tobacco smoking outcome, regression results listed in Table 3, the CPC preschool measure surfaced as a statistically significant (p<.05) predictor in model 1. The program group had an adjusted rate of young adult daily tobacco smoking that was 5 percentage points lower than the preschool comparison group (17.8% vs. 22.8%). In model 2, addition of the school-age CPC measure reduced the parameter estimate of the preschool measure to a statistically non-significant level. Classroom adjustment was entered in model 3, and yielded a significant (p<.01), negative relation to the outcome. Although attenuated, this statistically significant association remained in model 4, with the introduction of the middle/high school block of predictors. Of these predictors, frustration tolerance exerted a significant (p<.01), negative influence on the outcome. In the final model, with the addition of high school completion, classroom adjustment lost while frustration tolerance retained statistically significant predictive power. High school completion produced a significant (p<.01), marginal effect of−.129, and this last model explained approximately 7.5% of the outcome's variance.

Table 4 displays regression results for the frequent substance use outcome. In all models, the CPC preschool program had a small, non-significant, and positive association with the outcome. The school-age program's adjusted relation was negligible throughout the models, while classroom adjustment in grades 3–6, significantly predicted (p<.01) the outcome in the expected direction in model 3. In model 4, the significance of classroom adjustment's association with the outcome dropped below the .05 alpha threshold with the introduction of the middle/high school variables. Of these, both frustration tolerance (p<.05) and college attendance expectation (p<.01) had significant, negative associations with the outcome. These significant relations recurred in model 5, while high school completion also contributed to the outcome with a marginal effect of −.078 (p<.01). This model explained 14.6% of the outcome's variance.

Table 5, displaying output for models predicting the top quartile of depression scores, indicates that neither CPC program variable was associated with the outcome at a statistically significant level. When first introduced in model 3, however, classroom adjustment related to the outcome in the expected, negative direction and at the p<.01 alpha level. Grade 8 reading achievement mediated the main effect of classroom adjustment. The addition of high school completion, itself a significant predictor of the outcome at p<.01, did not reduce grade 8 reading achievement's relation to our depression indicator to a non-significant alpha level in the final model. This model only accounted for 4.3% of the variance in the outcome.

Last, Table 6 displays regression results from models predicting no health insurance coverage. Interestingly, the CPC preschool program measure displayed a statistically significant, inverse relation to the outcome throughout all five models. Introduction of the CPC school-age program variable only enhanced this effect, resulting in part from multicollinearity. The school-age program, however, did have a positive, non-significant relation to the outcome both on the bivariate and adjusted levels independent of the preschool program. The elementary school classroom adjustment measure related significantly (p<.05) and negatively to the outcome when entered in model 3. This relation lost statistical significance in model 4, although no middle/high school predictors forged a statistically significant association

[8] Not shown are parameter estimates associated with covariates, all of which were interpretable and stable. For instance, the risk index consistently generated a positive, statistically significant marginal effect on our indicators of poor adult health-related outcomes.

Table 4 Marginal effects of hierarchical probit models predicting frequent substance use (N=1,128)[a]

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5
CPC program participation					
CPC preschool	.002	.003	.008	.009	.015
CPC school-age (grades 1-3)		−.001	.002	−.000	−.002
Elementary School Classroom Adjustment					
Socioemotional classroom adjust. (grades 3-6)			−.008**	−.004	−.003
Middle/high school adjustment & achievement					
Frustration tolerance (grades 6–7)				−.007*	−.006*
Reading achievement (grade 8)				.000	.000
College attendance expectation (grade 10)				−.093**	−.077**
Educational attainment					
High school completion (by Sept. 2001)					−.078**
Pseudo R^2	8.84%	8.85%	10.38%	12.86%	14.59%

*p<.05 **p<.01 [a] Models adjusted for the following covariates: sex, race, early child welfare history, low birth weight, and a 7−item risk index.

with the outcome. In model 5, high school completion was a significant predictor of the outcome (p<.05) along with CPC preschool (p<.01). This model explained about 8% of the variance in the outcome.

For all outcomes, exploration of the two alternative predictor models did not alter the pattern of findings. That is, introduction of the propensity scoring variable in all study models yielded neither a statistically significant parameter estimate associated with this predictor nor a notable change in the alpha significance levels associated with the remaining school-based predictors. The same null findings resulted from the introduction of the variable identifying cases missing data on any of the risk items. These results indicated that our question 1 findings were robust to sample attrition associated with outcome and covariate measures.

Question 2

Examining results from question 1 revealed that mediation of early education-based measures by later ones occurred in the additive model sequence for at least three of the four study outcomes. For instance, preschool's relation to daily tobacco smoking was mediated by later-occurring predictors; classroom adjustment's relation to frequent substance use was mediated by frustration tolerance and college expectation; classroom adjustment's relation to depression was mediated by grade 8 reading achievement; yet preschool's relation to no insurance coverage was not mediated by any substantial amount by subsequent school-based predictors. Figures 1, 2, and 3 represent path models meant to more precisely uncover the means by which mediation unfolded. All path coefficients represent statistically significant (p<.05) fully standardized estimates.

Figure 1 reveals that the paths through which the preschool program linked to the daily tobacco smoking were primarily two-fold. The first set of paths, appearing in the upper portion of the figure, extended from CPC preschool to grade 8 reading achievement and high school completion, from grade 8 reading achievement to high school completion and from high school completion to

Table 5 Marginal effects of hierarchical probit models predicting top quartile of depression scores (N=1,134)[a]

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5
CPC program participation					
CPC preschool	−.025	−.025	−.019	−.010	−.002
CPC school-age (grades 1-3)		.000	.004	.005	.004
Elementary school classroom adjustment					
Socioemotional classroom adjust. (grades 3–6)			-.011**	-.005	-.003
Middle/high school adjustment & achievement					
Frustration tolerance (grades 6–7)				-.003	-.002
Reading achievement (grade 8)				-.002**	-.002*
College attendance expectation (grade 10)				-.038	-.022
Educational attainment					
High school completion (by Sept. 2001)					-.100**
Pseudo R^2	1.62%	1.62%	2.64%	3.39%	4.29%

*p<.05 **p<.01 [a] Models adjusted for the following covariates: sex, race, early child welfare history, low birth weight, and a 7-item risk index.

Table 6 Marginal effects of hierarchical probit models predicting no insurance coverage (N=1,277)[a]

Predictors	Model 1	Model 2	Model 3	Model 4	Model 5
CPC program participation					
CPC preschool	−.077**	−.088**	−.085**	−.084**	−.079**
CPC school-age (grades 1-3)		.014	.018	.017	.016
Elementary school classroom adjustment					
Socioemotional classroom adjust. (grades 3–6)			−.008*	−.007	−.005
Middle/high school adjustment & achievement					
Frustration tolerance (grades 6–7)				−.001	−.001
Reading achievement (grade 8)				.000	.000
College attendance expectation (grade 10)				−.067	−.056
Educational attainment					
High school completion (by Sept. 2001)					−.076*
Pseudo R^2	7.00%	7.08%	7.46%	7.69%	8.06%

*p<.05 **p<.01 [a] Models adjusted for the following covariates: sex, race, early child welfare history, low birth weight, and a 7-item risk index.

tobacco use. These paths, representing direct and indirect mediation, encompassed the cognitive/academic domain. One route of prevention from early CPC intervention to tobacco use, therefore, traveled through positive academic performance. A second general pathway incorporated social adjustment and motivational measures. In this progression, preschool participation led to CPC school age participation, which enhanced elementary school classroom adjustment. Classroom adjustment in turn strongly linked to reading achievement and high school completion along with college expectation and frustration tolerance. High school completion and frustration tolerance then connected to the outcome. Strength of overall pathways is determined through multiplicative calculations of coefficients from adjacent paths. The cognitive/academic pathway relative to the social/motivational pathway represented the stronger general effect in this model given the more direct route through which it manifested.

Figure 2 reveals that grades 3–6 classroom adjustment's main effect relation to frequent substance use was fully mediated by later-occurring education-related factors. High school completion provided direct mediation in this model, as did college attendance expectation and frustration tolerance. Indirect mediation traveled through all three middle/high school measures and high school completion. This model reveals that classroom adjustment actualized long-term influence on frequent substance use through direct effects on social/emotional, cognitive/academic, and motivational domains.

Figure 3 also demonstrates that intervening study measures fully mediated grades 3–6 classroom adjustment's significant main effect association with the study's depression outcome. In this model, direct mediation occurred through high school completion and grade 8 reading achievement, whereas college expectation and frustration tolerance contributed to the model only through indirect effects via high school completion.

Discussion

Major Study Contributions

Study results support the notion that educational attainment prevents unwanted health outcomes among urban-dwelling, disadvantaged minorities. A general and robust finding in our analyses was that young adults in the CLS sample who completed high school by age 21

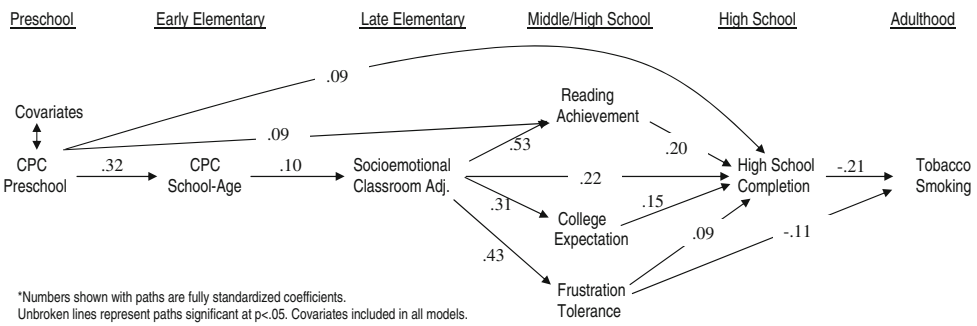


Fig. 1 Mediator Model for Ages 22–24 Daily Tobacco Smoking (N=1,125)* Preschool Early Elementary Late Elementary Middle/High School High School Adulthood *Numbers shown with paths are fully standardized coefficients. Unbroken lines represent paths significant at p<.05. Covariates included in all models.

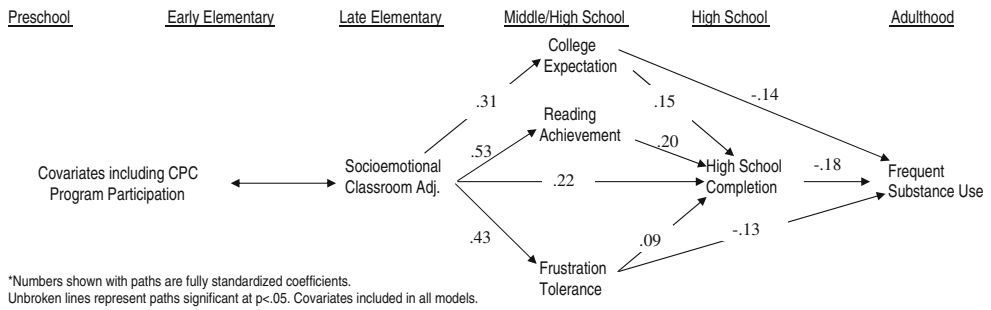


Fig. 2 Mediator Model for Ages 22–24 Frequent Substance Use (N= 1,128)*. Preschool Early Elementary Late Elementary Middle/High School High School Adulthood. *Numbers shown with paths are fully standardized coefficients. Unbroken lines represent paths significant at $p<.05$. Covariates included in all models.

fared significantly better on all four study outcomes relative to those who did not complete high school. Adjusted percentage point differences between completers and non-completers in rates of outcomes assessed ranged from 7.6% to 12.9%. Completing high school reduced chances of smoking tobacco daily by 48% (from 27% to 14.1%), of frequently using illicit substances by over 53% (from 14.6% to 6.8%), of having a depression scale score in the top quartile by 33% (from 30% to 20%), and of having no health insurance coverage by 20.3% (from 37.4% to 29.8%). Only 64% of the sample completed high school by age 21, a notably smaller rate compared to state and national norms (see Ou and Reynolds 2008); therefore, for these youth, completing high school represented a significant accomplishment with health implications.

Given the temporal proximity between high school completion and the measurement of our health-related outcomes, we questioned whether this education/health link was due to immediate effects of high school completion or to longer-term trajectories. Developmental theory would validate both explanations given the importance of developmental milestones and of accumulated life experiences. Our examination of earlier education-related measures revealed that these factors contributed to longitudinal mediating paths and to high school completion. They influenced, in other words, significant early trajectories and a later milestone related to young adult health outcomes.

All three study measures in the middle/high school block of predictors, for instance, directly linked to high school completion and additionally to at least one of the study outcomes. For instance, frustration tolerance, representing emotional regulation and social adjustment in adolescence, contributed to reduced rates of daily tobacco smoking and frequent substance use net of educational attainment. Although the frustration tolerance-education attainment connection was somewhat weak and might not hold up in more comprehensive predictor models (see Smokowski et al. 2004), it represents a likely developmental factor contributing to school success (e.g., Zins et al. 2007). More importantly, the role emotion regulation plays in compensatory use of substances including tobacco is well established (e.g., Wills et al. 2006). Our study suggests that school-based measures of this construct can contribute to outcomes such as substance/tobacco use. Tenth grade college attendance expectation also linked to frequent substance use directly and indirectly through educational attainment. In other studies, future orientation and school commitment have been found to predict educational attainment and drug use among adolescents (e.g., Ou and Reynolds 2008, Zimmerman and Schmeelk-Cone 2003). According to these findings and our own, supporting commitment to school

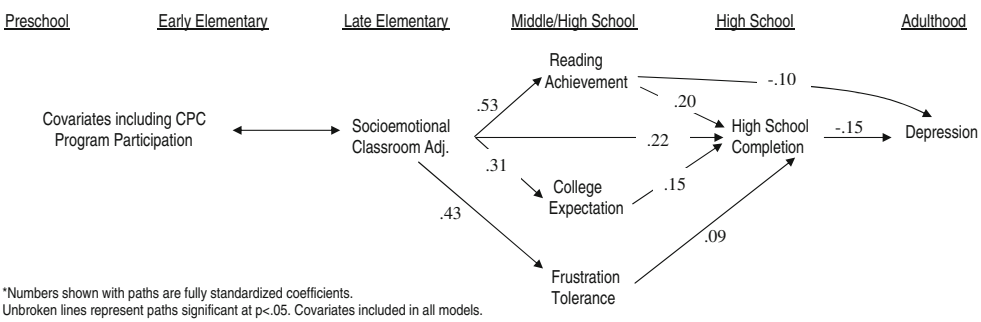


Fig. 3 Mediator Model for Ages 22–24 Top Quartile of Depression Scores (N=1,134)* Preschool Early Elementary Late Elementary Middle/High School High School Adulthood *Numbers shown with paths are fully standardized coefficients. Unbroken lines represent paths significant at $p<.05$. Covariates included in all models.

trajectories and future orientation for adolescents can impact both educational attainment and later health behavior. Last, our measure of grade 8 reading achievement strongly predicted high school completion and protected against high scores of depression net of high school completion. This latter finding is somewhat unexpected given we conceptualized reading achievement as a cognitive/academic indicator. It is congruent, however, with Masten et al. (2005) who found that poor school performance in adolescence predicted later internalizing symptoms in young adulthood, a phenomenon authors attributed to cascade effects whereby maladaptation in one domain of development spills over into another over time.

Our results also revealed that the paths from school-level factors to young adult health outcomes predated even middle school processes. In fact, grades 3–6 socioemotional classroom adjustment fulfilled a central role in the predictive pathways from school functioning to the outcomes of interest. Although in all cases middle and high school measures mediated its original main effect, the early classroom adjustment experience represented a crucial school-based factor that set some sample members on a path toward healthier young adult patterns versus others. In fact, this measure functioned as the earliest school-based protective factor significantly and inversely related to two study outcomes: frequent substance use and depression. When subsequent school-based measures were entered into our path model, early classroom adjustment linked very strongly to each. Fothergill and Ensminger (2006) demonstrated significant connections between early classroom behavioral regulation factors and later substance use issues. Further, researchers from fields as disparate as economics, neurobiology and prevention science extol the importance of early social-emotional development for long-term adjustment (e.g., Greenberg et al. 2003; Heckman 2000). Our results support such perspectives.

For two other study outcomes, pathways to well being originated with CPC preschool program participation. For instance, preschool attendees smoked tobacco daily at a 22% lower rate than non-attendees (17.8% vs. 22.8%). This effect was statistically significant (p=.048) but somewhat modest[9]. Its magnitude, however, ought to be considered within the following frameworks. First, daily tobacco smoking represents a severe health risk; hence, any believable preventive effect carries practical implications. Second, the intervention targeted outcomes unrelated to tobacco use, so this finding is serendipitous. Third, the intervention served young children, approximately two decades prior to the measurement of tobacco smoking. The program's long-term impacts most likely derived from its sound theoretical orientation, well-articulated organizational structure, high staff/student ratio, quality language-centered curriculum, comprehensive service model, well-trained and well-compensated staff, high implementation fidelity, and program delivery at a sensitive stage of developmental. This last point most strongly distinguishes the CPC preschool program from the CPC school-age program, and probably explains the inability of the school-age program to relate significantly to any study outcomes even at the bivariate level. The school-age program did, however, help explain CPC long-term effects in our path models. In Fig. 1, for instance, the school-age program extended CPC preschool impacts on socioemotional development, congruent with earlier CLS studies (Reynolds 2000). This pathway, along with others, helped to fully mediate CPC preschool's original main effect on daily tobacco smoking, reinforcing our understanding of educational success's potential to protect against smoking.

CPC preschool program attendance also resulted in a 20.4% lower likelihood of not carrying health insurance as a young adult (37.8% vs. 30.1%). To our knowledge, this finding is unique for preschool programs. The intervening measures of this study did not mediate, by any practical amount, this main effect. This null finding warrants further investigation.

Limitations

Strengths of this current study include its prospective data collection design, longitudinal nature, theory-base, and diversity of measurement sources. Limitations exist, however, and include the following. First, it was exploratory in nature. The study addressed, for the most part, research questions posed for the first time in the CLS. Salient predictor measures, either unavailable or unexamined, were in all likelihood omitted, including adolescent indicators of our adult outcome measures. This may have contributed to the predictor models' inability to account for more than 14.6% of the variance in study outcomes. To address this limitation, we based our choice of predictors on a priori theory application and model testing. Second, the set of variables selected

[9] This result is not robust to alternative model specifications. For instance, when environmental risks are characterized as single-item covariates in comprehensive predictor models, CPC preschool does not exert a statistically significant main effect on daily tobacco use (see Reynolds et al., 2007).

for our predictor and mediator models was confined to the category of education. Not only did this lead to the exclusion of other significant health predictors, but it also restricted our mediation analysis strategy. For instance, testing non-comprehensive mediation models with structural equation modeling (SEM), a more advanced strategy than traditional path modeling, can lead to misleading findings. When we employed SEM to address research question 2, as expected, we obtained unstable path estimates. Third, CLS attrition affected study variables. In response, we utilized imputation methods that drew on known variable relations and valid variable values within the dataset. Additionally, we compared attrition samples to study samples, and included measures in analyses on which these samples varied significantly. Last, we explored possible effects of missing data through alternative regression tests. Nonetheless, missing data affects confidence in our findings.

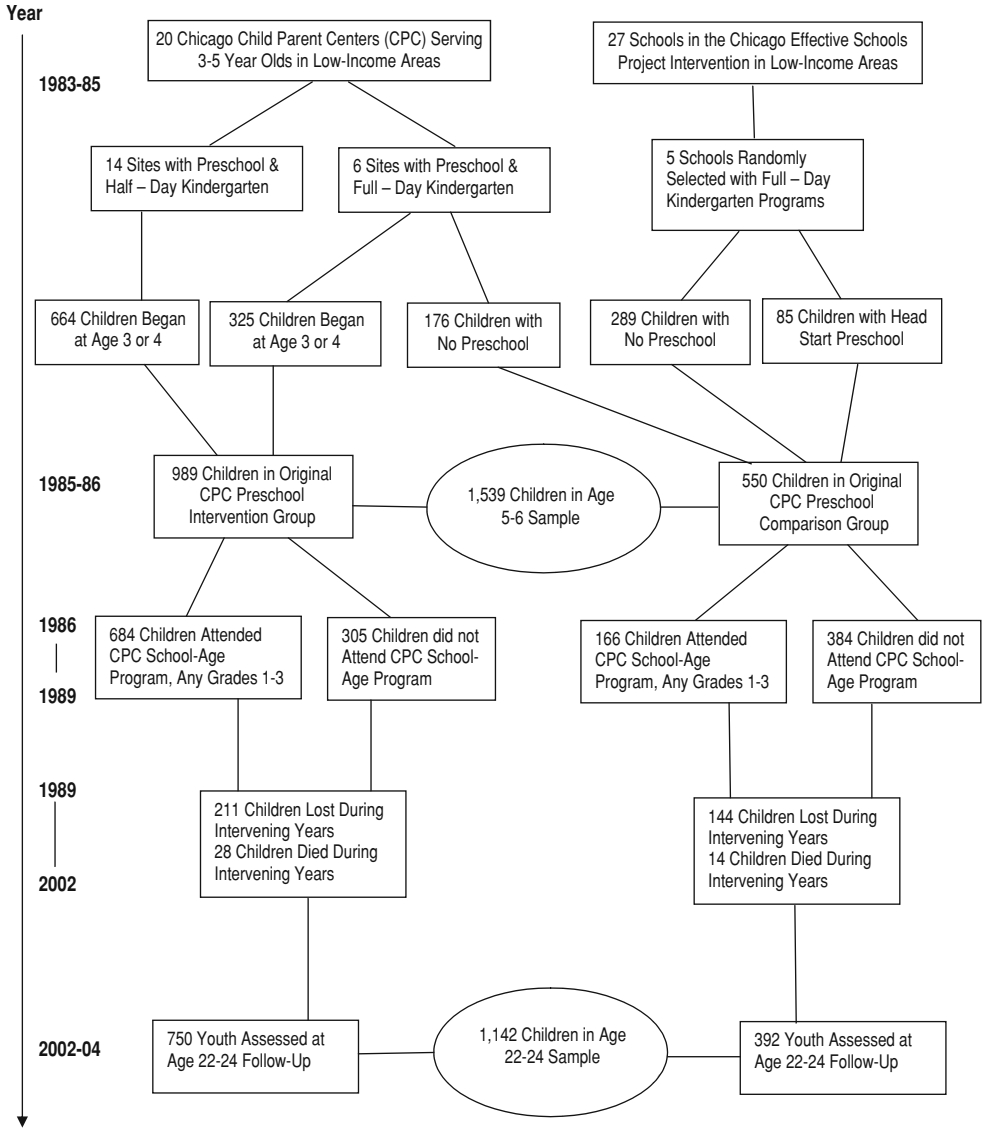
Implications

Three primary implications follow from our study results. First, given the robustness of the finding that high school completion prevented poor young adult health outcomes in the CLS, the importance of completing high school for this sample cannot be overstated. Implementation, therefore, of evidence-based practices that promote high school completion, especially among populations with a history of limited access to quality education, might not just represent good education policy but also good public health policy. Recent findings from the CLS identified several risk factors for educational attainment, including early absenteeism, grade retention, and school mobility. Factors facilitating educational success included parent involvement in school, student's college attendance expectation, and attendance at a magnet high school (Ou and Reynolds 2008). Programs that cultivate student and family investment in school early in the life course, such as the CPCs, the High/Scope Perry Preschool, the Abecedarian Project, and the Seattle Social Development Program (SSDP; Hawkins et al. 2001), are enriching factors that lead to school success and precluding processes that culminate in school dropout. In so doing, they may be contributing to positive health trajectories for low income, disadvantaged students.

Second, given the emergence in this study of grades 3–6 socioemotional classroom adjustment as a consistent predictor of educational attainment and health-related outcomes, we would recommend that schools support socioemotional classroom adjustment as a means to improve student outcomes and adult well being. This concept is not altogether novel as school-based interventions such as the PATHS curriculum and the SSDP, by targeting socioemotional skills, capitalize on the foundational nature and broad-ranging effects of social-emotional development (e.g., Greenberg et al. 2003; O'Donnell et al. 1995). Further, previous CLS studies found that the CPC school-age program along with kindergarten word test performance and early parental involvement in school enhanced students' socioemotional classroom adjustment in elementary school, which in turn contributed to positive adolescent development and educational attainment (Reynolds and Gill 1994; Reynolds et al. 2004). We conclude that school interventions solely targeting cognitive domains may miss other important components of school success that influence adolescent and adult functionality.

Last, results from this study revealed that health-related outcomes in early adulthood can extend back to participation in a high-quality, comprehensive preschool program. This also is not an entirely novel finding, but we uncovered several pathways of effect through which this longitudinal relation unfolded, adding confidence and insight to the results. Specifically, these pathways included school-based socioemotional, motivational and achievement domains. The CPC preschool program, for instance, linked directly to markers of academic performance, which then related directly to the health outcomes of interest. The program also related indirectly to indicators of socioemotional and motivational development, which then connected to our health outcomes. Several implications follow. First, comprehensive preschool interventions ought to be implemented in low income, urban communities of color given for, among other considerations, potential impacts on health disparities. Second, modifications to the CPC preschool program model to enhance effects on socioemotional and motivational development might be considered. The program targeted language acquisition and parental involvement yet did not include an intentional focus on socioemotional or motivational development. Incorporating such a curricular component could result in direct rather than indirect program links to later indicators of competence in these domains. At least one published evaluation of another preschool program revealed the potential benefits of introducing social-emotional competencies into the intervention design (see Domitrovich, Cortes, & Greenberg 2007).

Appendix A: Flowchart of study sites and participants in the Chicago longitudinal study for the adult survey sample



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