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Childhood Predictors of Adult Substance Abuse

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Abstract

Identification of the early determinants of substance abuse is a major focus of life course research. In this study, we investigated the child, family, and school-related antecedents of the onset and prevalence of substance abuse by age 26 for a cohort of 1,208 low-income minority children in the Chicago Longitudinal Study. Data on well-being have been collected prospectively since birth from administrative records, parents, teachers, and children. Results indicated that the prevalence of substance abuse by age 26 was 32 percent (self reports or criminal justice system records) with a median age of first use of 17. Probit regression analysis indicated that substance abuse prevalence was primarily determined by gender (males had a higher rate), trouble making behavior by age 12, school mobility, and previous substance use. Family and peer predictors included involvement in the child welfare system by age 9, parent expectations for school success at age 9, parent substance abuse by children's age 15, and deviant peer affiliation by age 16. Age of first substance use was predicted by gender and race/ethnicity (males and Blacks had earlier incidence), involvement in the child welfare system, and family risk status at age 8. As with prevalence, the pattern of predictors for males was similar to the overall sample but the magnitude of effects was stronger. The predictors of the timing of substance use dependency were gender, family conflict by age 5, involvement in the child welfare system, social maturity at age 9, adolescent school mobility, and school dropout by age 16. Findings indicate that the promotion of family involvement and positive school and social behavior can reduce the risk of substance abuse.

Keywords

substance abuse; drug use; longitudinal design; prediction; child development

Substance abuse exacts high personal and social costs that have been well-documented. Besides contributing to school underachievement, antisocial behavior, and mental health problems into adulthood (Belcher & Shinitzky, 1998; Gilvarry & McArdle, 2007; Hawkins, Catalano, & Miller, 1992; Merline, O'Malley, Schulenberg, Bachman, & Johnson, 2004), substance use and abuse is linked to increased expenditures for treatment in social service,

criminal justice, and health service systems (Monge et al., 1999). Given these serious consequences and growing costs of treatment, identifying malleable risk factors is critical for understanding as well as reducing and ultimately preventing substance abuse and its negative consequences for well-being.

These consequences are magnified by the relatively high prevalence of substance use among young people. While 10% to 15% of teenagers have used cannabis by age 15 (Fergusson, Lynskey, & Horwood, 1993), and 8.9% of 12-17 year olds have been diagnosed with substance use disorders (Substance Abuse and Mental Health Services Administration, 2004), substance use problems become increasingly prevalent during middle and late adolescence. Approximately 25% and 56% of teenagers by grade 8 and grade 12, respectively, have experienced illicit drug use (Johnston, O'Malley, & Bachman, 1999). Similar increasing prevalence of drug use were found in the National Clearinghouse on Alcohol and Drug Information, which reported that 20% of 16-17 year olds have experience of marijuana use at least once per week compared to 12% of 12-13 year olds. On the other hand, a declining pattern of use has been found after young adulthood (Merline et al., 2004). Based on these high prevalence rates and associated problem behaviors, it is necessary to explore the connection between substance use and substance abuse, which influence the long-term well-being.

Predictors of Substance Use Problems

Many risk and protective factors influencing drug use and abuse in adolescence and early adulthood have been identified (Hawkins et al., 1992; Young, Corley, Stallings, Rhee, Crowley, & Hewitt, 2002). Risk factors indicate that the increase in a specific variable is associated with increased likelihood of substance use/abuse. Protective factors denote that the increase in a specific attribute or behavior is associated with decreased likelihood of substance use/abuse. Individual, family, school-based, and peer contexts are most associated with the development of substance abuse. Hawkins et al. (1992) and Gilvarry and McArdle (2007) found that early antisocial behavior is associated with increased risk of substance use. For example, boys exhibiting persistent aggressive behavior are more likely to use drugs. Girls having higher levels anxiety are at increased risk of drug use. Conduct problems and hyperactivity in childhood and adolescence are more likely to be associated with drug use. Additionally, Merline et al. (2004) found that individual substance use history during senior year of high school predicts substance use in early adulthood.

Early family adversity is predictive of an increased risk of substance use and abuse in late adolescence and young adulthood (Siebenbruner, Englund, Egeland, & Hudson, 2006). Specifically, adverse family experience in childhood including emotional and physical abuse/neglect, sexual abuse, family dysfunction such as parental separation or divorce, single-mother status, parental substance abuse, and larger family size increased the risk of substance abuse (Bennett & Kemper, 1994; Dube et al., 2003; Hawkins et al., 1992; Osler, Nordentoft, & Andersen, 2006). Hawkins et al. (1992) found that a family history of alcoholism, parental use of illegal drugs, poor family management practices, family conflict, and low bonding to family were associated with drug use in adolescence. Reinhertz, Giaconia, Hauf, Wasserman, and Paradis (2000) indicated that sibling substance use

disorders, larger family size, lower socioeconomic status, and parental substance abuse, and younger parents were associated with an increased drug abuse in young adulthood. The family impact on the development of substance abuse varied by gender. Family environment was more influential on drug use problems for girls than boys (Block, Block, & Keyes, 1988)

Besides individual and family factors, school factors play an important role in substance use in adolescence and young adulthood. Osler et al., (2006) found that participants who disliked school had a greater risk of substance abuse. Evidence also shows the relationships between the academic risk factors including enrollment status and last semester's grades and past year marijuana use. School dropout is associated with a higher risk of substance use. Students with poor academic achievement had an increased risk of substance use problems (Hawkins et al., 1992). Negative relationships were also found between the lack of school attachment and commitment and the development of substance abuse (Young et al., 2002).

Peer behaviors and attitudes also influence the emergence of tobacco and drug use (Kandel, Simcha-Fegan, & Davis, 1986). Brook et al. (1998) found that peer factors have a direct and significant effect on adolescents' use of drugs. Peer pressure has impact on adolescent drug use (Robin & Johnson, 1996). Hawkins et al. (1992) found that early peer rejection and social forces to use drugs explained the drug and alcohol problems in adolescence. What probably occurs is that individuals affiliated with peers who use drugs, consume alcohol, and get in trouble are more likely to use drugs and become drug-abusers in young adulthood. For example, Fergusson, Swain-Campbell, & Horwood (2002) found evidence of consistent associations between deviant peer affiliations and crime/substance abuse in adolescents and young adults with the statistical control of confounding factors. The effect of peer factors on drug use problems, however, decreases with age.

Other studies have shown that neighborhood adversity is one of the critical contextual factors related to substance abuse. Residence in high-poverty neighborhoods increases the risk of drug use (Galea, Ahern, & Vlahov, 2003). Similarly, Cooper, Friedman, Tempalski, and Friedman (2007) found that residential segregation (isolation and concentration) is positively related to substance abuse in African-Americans.

Finally, previous research reveals that the most effective interventions for preventing substance abuse as well as delinquency, and violence are target early risk factors before antisocial behavior occurs (Webster-Stratton & Taylor, 2001). School-age programs that strengthen social skills and positive classroom behavior, parent-child interactions, and a broader set of resistance skills (Belcher & Shinitzky, 1998) demonstrate effectiveness in reducing substance abuse and associated problem behaviors. Preschool programs that improve school readiness and achievement as well as family and school support also show evidence of reducing later behavior problems that lead to substance abuse (Campbell et al., 2002; Reynolds et al., 2001, 2007; Schweinhart et al., 1993, 2005). However, few if any studies have investigated the long-term effects of early interventions into adulthood. While preschool programs have examined adult well-being, substance abuse has rarely been assessed.

Despite the progress in understanding the development of substance abuse and related problems, several limitations in knowledge remain. Most previous studies were analyzed using cross-sectional data. Few investigated the antecedents of substance abuse prospectively and with longitudinal designs. In addition, the determinants of the onset of substance use and progression to substance abuse or dependency were not well documented. Moreover, few studies have examined comprehensive models of the predictors of substance abuse that include child, family, school, neighborhood, and peer factors and experiences measured over the entire period of childhood and adolescence. Such an approach is consistent with a developmental and life course perspective.

Present Study

In this study, we investigate the predictors of early adult substance abuse using data from the Chicago Longitudinal Study, an on-going prospective investigation of the life course of a cohort of 1,539 low-income minority children growing up in the inner city. Three major questions are addressed:

- A. What factors predict the incidence of substance abuse by age 26?
- B. Which factors predict the age at first substance use?
- C. Which factors predict substance dependency?

In addition to the focus on children with demographic attributes that place them at risk of later problematic behaviors, the CLS has a number of strengths that can advance knowledge about the development of substance use and abuse. First, extensive data have been collected from birth to early adulthood on many individual, family, school, and community influences. A significant number of measures ranging from participation in intervention to parenting and school practices are alterable and can be a focus of preventive efforts. Second, the study has high rate of sample recovery. Over 80% of the original sample has provided data on a regular basis from early childhood to early adulthood. Finally, multiple sources of information are available on substance use and abuse, including self-reports and administrative records. This feature strengthens the construct and measurement validity.

Method

Sample and Data

The sample participates in the Chicago Longitudinal Study (CLS, 2005), a prospective investigation of the life-course development of a cohort of 1,539 low-income minority children (93% African American, 7% Hispanic) growing up in the inner city. Although the major focus is assessing the impacts of the Child-Parent Center program on health and well-being, the CLS also investigates the influences of child, family, and school factors on life course development. The original study sample included a cohort of 989 children enrolled in the CPC preschool program in 20 sites in preschool and kindergarten during 1985-1986. It also included a matched cohort of 550 children of the same age enrolled in alternative preschool programs in 5 different Chicago public schools, which were randomly selected from 27 sites participating in the Chicago Effective School Project in similar, impoverished neighborhoods (Reynolds et al. 2001).

The sample for the current study was 1,208 participants (78% of the original sample), who completed the adult survey at ages 22-24 or who had official drug criminal records (i.e., drug conviction) at county, state, and/or federal level by age 26. Table 1 shows that the characteristics of the children and families in the study sample matched those of the original sample. For example, the samples were similar on gender composition, parent education and single-parent status, overall family risk status, CPC participation, and children's kindergarten achievement test scores.

Data in the CLS on demographic characteristics and individual, family and school experiences were collected prospectively. The CLS includes (among others) the following data sources: teacher surveys (yearly, kindergarten to grade 7), parent surveys (student grades 2, 4-6, and 11), student surveys (grades 3-6 and 10), young adult survey (age 22-24), the Illinois Department of Public Health, Cook County Juvenile and Circuit Court records, and the Illinois Public Assistance Research Database (ILPARD) maintained by Chapin Hall Center for Children at the University of Chicago. School data and peer variables were collected from the Chicago Public Schools. Family data include public assistance, education, employment, and family structure were collected on application to public assistance from February 1, 1989 to August 31, 2008.

Explanatory Variables

Table 2 shows the explanatory variables of the study by demographic, early and middle childhood, and adolescent attributes including family, school, and peer influences. Many previous studies have emphasized early childhood predictors (Dube et al., 2003; Osler & Nordebnftoft, 2006; Siebenbruner et al., 2006) while others have focused on school and peer influences in early adolescence (Hawkins et al., 1992; Brook et al., 1998; Fergusson et al., 2002). In this study, we focus on a comprehensive set of predictors spanning preschool to adolescence and inclusive of child, family, and school-related influences. These are defined below.

Gender—Males were coded 0 and females were coded 1. Data were from school records upon entry to preschool or kindergarten.

Race/ethnicity—This was also measured from school records. Hispanic children were coded 0 and African-American children were coded 1.

CPC preschool participation—This dichotomous variable indicated whether the child attended a CPC preschool program at age 3 or 4 using administrative data from the Chicago Public Schools. Children who enrolled at age 3 had two years of this part-day program and those who enrolled at age 4 had one year. The comparison group was coded 0 and they participated in the usual early educational intervention for children at risk, which was a full-day kindergarten program in the Chicago Public Schools. Although none participated in CPC preschool, 15% of the comparison group attended the Head Start preschool program.

CPC school-age participation—This dichotomous variable indicated whether the child attended the school-age component of the CPC program for one or more years (age 6-9) from first grade to third grade (ages 6-9). The school-age programs was affiliated with the

same elementary schools as the preschool program. Data were from school administrative records of the Chicago Public Schools. Those coded 0 did not attend the CPC school-age program.

Involvement in child protective services—The dichotomous variable indicated whether the child or family received child protection services at ages 4 to 9 based on the reports of the Child Protective Services Division of the Illinois Department of Child and Family Services and/or petitions to the Cook County Juvenile Court.

Frequent family conflict—This dichotomous variable indicated the presence of frequent family conflict when the participant was 5 to 10 years of age. In a retrospective life event checklist in the adult survey, sample members were asked the following: “We are interested in major events that have occurred in your life. Please indicate if any of these events have occurred in your life.” “If yes, how old were you when this happened?” One life event was “frequent family conflict.” The validity of these retrospective reports was corroborated by findings that family conflict was positively correlated with risks measured by other sources (e.g., child maltreatment, family risk status) and negatively correlated with child outcomes such as school achievement.

Parent substance abuse experience—Two dichotomous variables were used to measure the history of parental problems with substance abuse when the participants were ages (a) 5 to 10 and (b) 10 to 15. Data came from retrospective reports on the adult survey at age 22-24. In the life events checklist, participants were asked the following: “We are interested in major life events that have occurred in your life. Please indicate if any of these events have occurred in your life?” “If yes, how old were you when this happened?” One of these life events was “problem of substance abuse of parent.” In support of validity, these retrospective reports were positively correlated with other risk factors and experiences (e.g., child maltreatment, family risk status) and negatively associated with indicators of children's school progress and achievement.

Social maturity, ages 7-9—Teacher ratings of children's social adjustment were assessed by a 6-item scale measured from first to third grade. The items were as follows: concentrates on work, follows directions, is self-confident, participates in group discussions, gets along well with others, and takes responsibility for actions. Responses were coded from poor/not at all (1) to excellent/very much (5). We used the average of the available scores over the three-year period. Reliability (alphas > .90) and predictive validity of the scale are high (Ou & Reynolds, 2008).

Family risk index—This continuous variable was the sum of eight dichotomously-coded family risk factors measured at age 8 from family surveys, school records, and social-service records. They included (a) single-parent family status, (b) mother did not completed high school, (c) mother was under age 18 at child's birth, (d) teenage mother at childbirth, (e) family participation in the public assistance programs, (f) mother unemployment status, (g) free lunch eligibility, (h) 4 or more children in the household, and (i) residence in low-income neighborhoods.

Parent expectations of child's progress, ages 8-10—This variable was the average of teacher ratings over grades 2 to 4 on the item “Parent's expectations of child”. Responses ranged from “poor/not at all” (1) to “excellent/much” (5). The item was part of a survey of children's classroom adjustment and school experiences (i.e., “Please rate the child on the following characteristics..” Scores for two or more occasions were averaged. Teacher ratings of parent expectations (and related parenting measures such as school involvement) showed construct independence from child ratings of school adjustment and performance.

Intrinsic motivation, age 9-10—This 10-item scale of achievement motivation was self-reported in the spring of third and fourth grade as part of the student survey. Rated on a 3-point scale from not much (1) to (3) often, the items were as follows: (a) I like to learn things, (b) I like to write stories, (c) I get bored in school [reverse coded], (d) I like to read, (e) I like science, (f) I like to have books read to me, (g) like to do math, (h) I have fun at school, (I) learning is fun, and (j) I like to work on worksheets. Z-scores were analyzed and those available at both ages were averaged. The internal-consistency reliability coefficient was .66.

No trouble-making behavior, ages 9 to 12—This continuous variable of problem behavior was measured by a child-rated 4-item scale over grades 3 to 6. The items were (a) I get in trouble at school, (b) I fight at school, (c) I get in trouble at home, and (d) I follow class rules [reverse coded]. Item responses ranged from (1) often to not much (3). The scale was coded to index the extent of no problem behavior. Higher scores indicated more positive (less trouble-making) behavior; see also Topitzes et al., 2009). Scores available on 2 or more occasions were averaged. Given the relatively few items, the internal-consistency reliability of the scale was .55.

Reading achievement at age 10—This measure was reading comprehension as assessed by the reading comprehension subtest of the Iowa Test of Basic Skills (ITBS; Form J, Level 9 or 10; Hieronymus & Hoover, 1990). The subtest included 49 items on understanding text passages ($\alpha = .93$). Developmental standard scores were analyzed based on 1988 norms.

Personal substance use experience—This dichotomous variable indicated whether the participants had ever used illicit drugs up to age 15. Data came from multiple sources including youth survey at age 15-16 (“I use alcohol or drugs for nonmedical reasons.”), retrospective reports from the life event checklist in the adult survey (history of “problem of personal substance abuse”; see description of frequent family conflict above), and arrest records from the juvenile justice system.

School moves—The number of school moves were measured at three different age periods: 6 to 9, 10 to 14, and 14-18, corresponding to kindergarten to grade 3, grade 4 to 8, and grade 8 to 12. Data were derived from annual records of school enrollment in the Chicago Public Schools. Within-year and normative (expected due to grade promotion) moves were not included. Many previous studies show that non-normative school moves are associated with lower levels of school achievement and attainment (Mehana & Reynolds, 2004; Ou & Reynolds, 2008).

School quality—This was a dichotomous variable indicating whether study participants over ages 10-14 (grades 4-8) attended either (a) selective citywide magnet schools or (b) those in which 40% or more of the student body was at/above national norms in ITBS reading and math. Data came from the State of Illinois Report Card from the fifth grade year (1990-1991). Scores were highly consistent across the measured grades. Magnet schools have selective enrollment policies that require good school performance and high expectations for success.

School dropout—This dichotomous variable indicated if the child had ever dropped out of school by age 16. Data came from school system records supplemented with participant surveys. We used this early measure of dropout to avoid confounding the direction of influence between dropout and substance use.

Deviant peer affiliation—The dichotomous variable indicated whether most of the participants' friends exhibited any of these behaviors ("Most of my friends:"): (a) skip school a lot, (b) drink alcohol, (c) or have experimented with drugs. Otherwise, the code was 0. Data were based on self reports at the age 15-16 survey.at child's age 16 (1=most of friends skip school a lot, drink alcohol, or have experimented with drugs, 0=otherwise).

Outcome Measures

At ages 15-16 and 22-24, sample members were surveyed or interviewed about their well-being including school progress and performance, attitudes toward education, socio-emotional development, health behavior, school support, peer relations and family experiences. As part of these surveys, participants reported their use of tobacco, cannabis and other illicit drugs problems. The age 22-24 survey/interview provided the most comprehensive assessment. This self-report information was combined with arrest records from juvenile and criminal justice system on drug possession, manufacturing/delivery, and conspiracy to construct the following measures: age of first substance use, substance abuse, and substance dependency. Table 2 shows the summary statistics of the measures. Table 3 shows the distribution of substance use by age of first use.

Age of first substance use—This was a continuous variable that indicates the age of first use of illicit drugs including marijuana and harder drugs from self reports (excluding alcohol) over ages 15 to 24 from the two major survey/interview assessments. These data were supplemented with official juvenile and adult justice system records of arrests for drug possession or manufacturing. We used the earliest identified age for any of these sources.

Each self-report assessment included items about current or past illicit drug use. In the age 22-24 survey/interview, participants answered the following questions: "Have you ever: "smoked marijuana" or "used drugs harder than marijuana." "If yes, how often do you currently use it?" The frequency of use was classified as "almost every day", "a few times a week", "a few times a month", "less than once a month", "a few times a year", and "never". Individuals also were asked about their history of "problems of personal substance abuse" over three age periods (5 to 10, 10 to 15, and 16 to 22-24). This question was part of a list of 17 life events. For the analysis, participants were classified as users if they reported any use

(regardless of frequency) on at least one occasion. In some cases, justice system data on drug arrests and convictions were used to determine the age of first substance use as were records of DUI (driving under the influence or drugs or alcohol) from the Illinois Department of Motor Vehicles.

Substance abuse—This was a dichotomous variable of the overall prevalence from ages 16 to 26 based on self reports and administrative records. Sample members were assigned a value of 1 if any of the following behaviors applied (otherwise 0): (a) self-report at age 22-24 of “any personal substance abuse problem from age 16 and above”, (b) self-report of presently “smoking marijuana almost everyday” or “using drugs harder than marijuana a few times per week or more”, (c) justice system records from age 16 to 26 of being found guilty of drug possession, manufacturing/delivery, or conspiracy as well as substance-related disorderly conduct, (d) use of substance abuse services based on the age 22-24 survey, and (e) Department of Motor Vehicle record of a DUI conviction since age 18.

Our definition was consistent with the Diagnostic and Statistical Manual of Mental Disorders (DSM) of the American Psychiatric Association (2000), which defines substance abuse as “a maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one(or more) of the following, occurring within a 12-month period...(1) recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home...(2) recurrent substance use in situations in which it is physically hazardous...(3) recurrent substance-related legal problems...(4) continued substance use despite having persistent or recurrent social or interpersonal problems..” Consequently, we classified individuals as substance abusers if they satisfied any of the following (among others): consumed drugs frequently, meaning, at least a few times a week, and had problems in school at age 16 or 17 (dropout, being retained); consumed drugs frequently and did not attend to any educational institution and was not employed when age 18 or older; consumed drugs frequently and had more than two drug-related arrests; and consumed drugs and had more than two drug-related convictions.

Substance use dependency—The primary measure was a continuous variable that indicates the number of years from the age of first substance use to substance dependency by age 26. Based on the same self-reports and administrative records listed above, the sample size was the 440 individuals with any lifetime substance use. From this sample, we identified 168 as having substance dependency. The presence of substance dependency was based on DSM-IV and DSM-IV-TR criteria of the American Psychiatric Association (2000). These included tolerance, frequency of substance use, time spent by the individual in activities necessary to obtain drugs, and important activities that were reduced or given up due to substance use (e.g. school retention, school dropout). If three of these criteria were satisfied at any time in the same 12-month period, then the individual was categorized as substance dependent. In order to categorize dependency for long periods of time, these criteria had to be satisfied for uninterrupted periods. In supplemental analysis, we also tested the predictors of the dichotomous measure of substance use dependency among those who had any history of use since age 16 ($n = 440$) and for the total study sample ($n = 1,208$).

Missing Data

We used multiple imputation with the expectation-maximization (EM; Schafer, 1987) method for the explanatory variables. The assumption is that values are missing at random (MAR). We imputed the variables depicted in Appendix A. Each variable was imputed on a set of explanatory variables by an appropriate model based on the imputed variable. The regression model is an OLS if the imputed variable is a continuous variable or a logit model if it is a binary variable. The set of explanatory variables used for our imputation are background characteristics: participant's gender, school site, years attending CPC preschool, kindergarten dosage (half day or full day kindergarten) and risk index at child's birth (marital status of parents, mother completed high school, mother's age, free lunch eligibility, mother's participation in the public aid program AFDC (Aid to Families with Dependent Children), school neighborhood poverty, mothers employment status and number of children in the household).

Data Analysis

The first research question examined the factors that predict the incidence of substance abuse by age 26. Consistent with prior research (Fergusson et al. 1993, Merline et al. 2004), we used probit regression analysis for model estimation. The probit model assumes that the probability distribution function is normal. We used the maximum likelihood estimation method using STATA in which the log-likelihood function is maximized as follows:

$$\ln L = \sum_{j \in S} \ln \Phi(x_j \beta) + \sum_{j \notin S} \ln \{1 - \Phi(x_j \beta)\} \quad (1)$$

In the model, Φ represents the cumulative normal and $(x\beta)$ the probabilities of substance abuse. The primary metric for interpretation is the marginal effect, the change in the probability of substance abuse associated with a one unit change in x .

For the second (predictors of age of first use) and third (time from first use to substance dependency) research questions, we used survival analysis. This approach has been rarely used to investigate a comprehensive set of predictors into adolescence. Based on the Cox (1972) proportional hazard model (see also Gutierrez, 2002), the hazard is the probably (relative risk) that participants will be a substance user as they age. The model assessed the predictors of “how long does it take?” to become a user. The duration of time is up to age 26. To analyze the use to substance dependency question, survival analysis was used to test the predictors of being classified as substance dependent given that an individual was already a substance user. The hazard (relative risk) is the probability that an individual will become dependent as the length of time (years is unit time interval) between use and dependency increases.

To illustrate the Cox proportional model for research question 3, let λ denotes the hazard rate, λ_0 be the baseline hazard (individual heterogeneity), x_i represents a constant term and a set of variables that are assumed not to change from time $T=0$ until the “failure time”, $T=t_i$, where T denotes the total length of duration and t denotes time. The approach is a semi-

parametric method that analyzes the effect of covariates (β s), without requiring the estimation of λ_0 , on the hazard rate.

$$\lambda(t_i) = \exp(x_i' \beta) \lambda_0(t_i) \quad (2)$$

Results

Descriptive Findings

By age 26, the study sample had a prevalence rate of substance abuse of 26% (see Table 2). The rate of substance use was 36% (a less restrictive definition). The rate of substance abuse included not only self-reports of frequent use or treatment but justice system records of convictions for drug possession. Given the similarity between the study sample and the original sample on many child and family characteristics (see Table 1), the prevalence rate would likely hold for the original sample. Nearly 90% of those with substance abuse were males. Consequently, we tested the predictors of abuse for males as well as the overall sample.

As shown in Table 3, the age of first use ranged from 9 to 26 with a mean of 17.2 years of age (median of age 17). Most of the cases had an age of first use from 14 to 19. Of the 440 participants with identified use, 38% (168 participants) met the definition of dependency by age 26. The average number of years from first use to dependency (among 168 with dependency) was 5.5 with a range of 3 to 16.

Appendix B shows the correlations among the explanatory and outcome variables. In general, the correlations among the explanatory variables were low to moderate. The highest correlations included teacher ratings of social maturity and parent expectations for child's school progress ($r = .61$) and reading comprehension and social maturity ($r = .56$). The association between personal substance use and parent substance use at child ages 10 to 15 was modest ($r = .23$). The explanatory variables most correlated with substance abuse prevalence were gender ($r = -0.47$ [females had lower prevalence]), personal substance use ($r = 0.25$), social maturity ($r = -0.24$), and parent expectations ($r = -0.22$).

Factors Predicting Substance Abuse in Early Adulthood

Findings of the explanatory model for substance abuse are shown in Table 4. Marginal effects (b) are reported and were converted from the probit coefficients. Marginal effects denote the change in the outcome in percentage points for each 1-unit change in the predictor after controlling for the influence of other model variables.

For the overall sample, three predictors were associated with a decreased likelihood of substance abuse by age 26: gender ($b = -0.35$ [in favor of females]; $p < .001$), no trouble-making behavior ($b = -0.03$; $p < .001$), and parent expectations of child's school progress ($b = -0.05$, $p < .05$). For example, an improvement of 2 points on the no trouble scale is associated with a 6 percentage point reduction in substance abuse. A similar change in parent expectations corresponds to a 10 percentage point reduction in substance abuse. Five

other predictors were linked to an increased likelihood of substance abuse: involvement in child protection services ($b = 0.17$, $p < .001$), parent substance abuse at child's ages 10 to 15 ($b = 0.10$, $p < .05$), school mobility at ages 14 to 18 ($b = 0.04$, $p < .05$), previous personal substance use at age 10 to 15 ($b = 0.46$, $p < .001$), and deviant peer affiliation ($b = 0.08$, $p < .01$). These findings indicate that family and school contexts contribute substantially to substance abuse even after previous substance use is taken into account.

As further shown in Table 4, the pattern of findings for males was similar to that of the overall sample (because of sample size limitations the model was not estimated for females). School mobility at ages 10-14 was the only additional predictor for males ($b = 0.06$, $p < .05$). Parent expectations, however, did not predict substance abuse. With the exception of substance use experience at age 10 to 15, the size of the coefficients was larger for males than for the overall sample. For the school mobility measures, the magnitude of influence was double. The influence of no trouble making ($b = -0.04$, $p < .001$), child protective services ($b = 0.22$, $p < .01$), and deviant peer affiliation ($b = 0.13$, $p < .01$) also were stronger.

Factors Predicting the Age of First Substance Use

We used survival analysis to examine the predictors of the age of onset of substance use. Findings are reported in Table 5 and are based on the Cox proportional hazard model. The hazard ratio (HR) indicates the relative risk of substance use per 1-unit change in the explanatory variable controlling for other model variables. Four variables were significant predictors of substance use onset. Involvement in child protective services at ages 4 to 9 was associated with an increased hazard ($HR = 1.39$; $p < .01$) or relative risk of earlier substance use. Relative to those not involved in child protective services, children in protective services had a 39% increased risk. Family risk status ($HR = 1.06$; $p < .05$) also was associated with an increased risk of earlier onset as was school mobility at ages 10-14 ($HR = 1.32$, $p < .001$). Each additional school move increased the risk of earlier substance use by 32 percent. Conversely, Black participants had a significantly lower risk of earlier onset ($HR = 0.74$, $p < .05$). This is a 26% lower risk than Hispanic participants.

The pattern of findings for males was nearly identical to that of the overall sample. School mobility, family risk status, and child protective service involvement. Although race ($HR = 0.73$ [Black participants had lower risk]; $p = .06$) and frequent family conflict ($HR = 1.4$; $p = .07$) were marginally associated with age of onset but the magnitude of effects was relatively large. Overall, findings suggest that family adversity exerts a sizable impact on the onset of substance use.

Factors Predicting Substance Dependency

Survival analysis was also used to predict the hazard (relative risk) from first substance use to dependency. This is a negative indicator of desistence. The sample size for this analysis was the 440 participants who had substance use by age 26. As shown in Table 6, there were 6 significant predictors of relative risk of substance dependency. Gender ($HR = 0.29$, $p < .001$ [females had lower risk]) and social maturity ($HR = 0.97$, $p < .05$) were associated with a decreased risk of substance dependency by age 26. A 5-point increase in social maturity, for example, would decrease the hazard of dependency by 15 percent ($[(1 - 0.97) \times 5]$).

Being female and social maturity are protective against substance use problems and increase desistence.

On the other hand, involvement in child protective services by age 9 ($HR = 1.83, p < .01$), frequent family conflict at ages 5 to 10 ($HR = 1.68, p < .05$), school dropout by age 16 ($HR = 1.52, p < .05$) and school mobility at ages 14 to 18 ($HR = 1.45, p < .05$) were associated with an increased hazard of substance dependency. Each of these experiences substantially increased by about 50% or more the likelihood of earlier ages of dependency or faster progression from use to dependency. While involvement in child protective services nearly doubled the relative risk of substance dependency, 3 school moves increased the relative risk (compared to no moves) by more than double. That the majority of the major predictors of dependency occur prior to age 10 is suggestive of the need for earlier preventive services.

We report the predictors of the dichotomous measure of substance dependency in Appendix C. This model does not account for age of dependency. There were some differences compared to the age hazard measure in Table 6. Besides gender, the significant predictors in the overall sample were race (Blacks had higher rates), frequent family conflict at ages 5-10, no trouble making behavior, and parent substance abuse experience at child's age 10-15. For example, each additional point on the no trouble making scale reduced the rate of substance dependency by 3.6 percentage points. For males, frequent family conflict and race were most predictive of substance dependency. Appendix D shows that the predictors of substance dependency using the entire study sample of 1,208 were consistent with those of the substance use sample of 440.

Discussion

This study investigated a comprehensive set of early childhood and adolescent predictors of three measures of substance use problems in early adulthood for an large urban cohort. We found that substance abuse is primarily determined by individual (trouble-making behavior and personal substance use experience), family (child protection services, parent expectations, and parent substance abuse), and school-related (mobility, deviant peer affiliations) measured up to the middle of adolescence. Early school dropout linked to a faster progression to dependency but not to overall prevalence or age at first use. Similar predictive patterns of substance abuse were found for males. About 90% of substance abusers were males. Not surprisingly, and consistent with extant research, substance use history and parent substance use predicted substance use problems (Young et al., 2002; Merline et al., 2004).

Consistent with previous studies (Hawkins et al., 1992; Osler et al., 2002; Reinherz et al., 2000), early family adversity (i.e., child protection services and family conflict) had a key role in predicting the onset of substance use and substance dependency. Alternatively, being female and have greater social maturity decreased the likelihood of progression to substance dependency. School factors in adolescence such as school mobility and school dropout also decreased the likelihood of progression to substance dependency. These findings are unique as previous research has not investigated factors that predict progression from substance use to dependency. The predictors of substance use and abuse, however, have been extensively

investigated. Findings have indicated that early family adversity and disadvantage, early antisocial behavior, and deviant peer affiliation are especially salient (Ferguson et al., 2002; Gilvarry & McCardle, 2007; Siebenbruner et al., 2006) even after substance use history is taken into account.

In this study, we found limited support that early school-age factors predicted substance use problems. Early school-age social maturity predicted substance dependency and teacher ratings of parent expectations for children's success predicted the prevalence of abuse at age 26. The comprehensiveness of the model—prior substance use and a host of other factors—may be responsible. The relatively large influence of home environment, for example, is likely to reduce or account for the effects of other variables on substance abuse and dependency (e.g. peer affiliation, see Appendix B correlation matrix). Frequent family conflict and involvement in child protective services due to child maltreatment were predictors of one or more of the substance use outcomes. This is consistent with the accumulated knowledge (Hawkins et al., 1992; Dube et al., 2003; Osler et al., 2006; Siebenbruner et al., 2006; Young et al., 2002).

Although associated with adverse early child and family experiences, school mobility was found to be a significant predictor of each measure of adult substance use. The impact of the number of moves was also largest for males—about double the effect size of the overall sample (see Tables 4 and 6). These findings are consistent with ecological (Bronfenbrenner, 1989) and social capital (Coleman, 1988) theories of life-course development, in which school transitions, especially if frequent, can disrupt peer networks, school learning environments, and relationships with teachers that culminate in higher risk of substance use problems in adulthood. Much previous research has found that school mobility links to lower school achievement and school dropout (Mehana & Reynolds, 2004; Reynolds, Chen, & Herbers, 2009; Rumberger, 2003). Because we found that early school dropout by age 16 independently predicted substance dependency, school failure may mediate the relation between mobility and substance abuse. Nevertheless, our study found that many individual, family, and school-related factors predicted substance use problems in adulthood and together they suggest approaches for prevention and cost savings.

Contributions to Previous Research

The prospective investigation of developmental precursors in early childhood, childhood, and adolescence contributes to the integration of knowledge about the predictors of substance use and its progression to abuse. Our study contributes to greater understanding of the development of substance use problems for at-risk students living in impoverished neighborhoods. It also provides relevant knowledge for the development and implementation of interventions to forestall and prevent substance abuse. This is one of the first studies using prospective longitudinal data to test a comprehensive model of the development of substance abuse, including the onset of substance use to dependency. Besides early childhood and family risk factors, individual, family, school, and peer variables were collected from multiple sources, which generated a full spectrum of ecological variables into early adulthood. One of the advantages of the longitudinal design is that the links between early precursors and later substance abuse problems can be more confidently defined as predictors

rather than as mere correlates. Consequently, the relatively strong predictive power of involvement in child protective services, parent expectations, trouble making behavior, school mobility, and deviate peer affiliation is unlikely to be affected by other confounding influences. Indeed, the breadth of the model reduces the risk of model specification errors. The consistently negative influence on substance use problems of school mobility beginning at age 10 is a further example of the strength of prediction from the model.

Besides the investigation of the factors associated with the onset of substance use and factors predicting later substance abuse problems in adulthood, this is one of the first studies to examine the factors predicting the time from substance use to substance dependency. The findings showed factors related to the persistence of and resistance from substance use. The major predictors, including family conflict, social maturity, involvement in child protective services, school mobility, and early school dropout, can all be altered by program or policy intervention. School mobility has not been previously identified as a predictor of substance use problems or dependency (Hawkins et al., 1992; Young et al., 2002).

More generally, the identification of malleable predictors in childhood through adolescence in the onset of substance use and progression to dependency contributes to knowledge about not only etiology of substance abuse but avenues of prevention and intervention. At an individual level, engaging children's pro-social behavior in classroom settings during the early school-age years may reduce the likelihood of subsequent substance abuse. At the family level, reducing economic stresses associated with poverty and related factors as well as promoting positive parenting practices that reduce family conflict and the risk of child maltreatment are likely to promote positive health behaviors. At the level of the school context, reducing school mobility and its detrimental effects was found to be particularly salient. This suggests that unstable learning environments may weaken the school bond and commitment to education (Hawkins et al., 1992; Osler et al., 2006) and thus lead to substance use problems. Moreover, the strong influence of deviant peer affiliations, which develops as a function of weakened school commitment (Fergusson et al., 2002; Galea et al., 2003; Hawkins et al., 1992), suggests that building supportive and positive social networks in adolescence may be especially beneficial to the prevention of substance use problems (Monge et al., 1999).

Limitations

Using existing data from the CLS, the sample was representative of at-risk children in low-income areas in Chicago, who attended early childhood intervention programs. Findings may not generalize to youth in non-urban or less disadvantaged contexts. Furthermore, the sample was almost exclusively African-American, which may limit generalizability to other racial and ethnic groups.

A second limitation is that although our study tested a comprehensive set of predictors of substance use problems, it is possible that other important factors were omitted. For example, neighborhood characteristics were only indirectly measured and early home environment experiences were limited to family demographics, involvement in child protective services and preschool participation. Of course, given the breadth of our model, the added value of these or other omitted variables would likely be small.

A third limitation is that some of our explanatory variables were based on retrospective reports including previous substance use, parent substance use, and family conflicts early in life.. Although such reports for salient life experiences are often accurate, the threat of recall bias cannot be ruled out completely. Moreover, other measures, such as parent expectations for children's school success, were from teachers and these reports have lower construct validity than parent or child reports.

Finally, by emphasizing the predictors of substance use problems, we did not investigate the mediators and developmental pathways leading to substance abuse problems and the extent to which these processes may vary by participant subgroups. Future research should more fully integrate predictors and mechanisms in the development of substance abuse.

Implications for Policy and Practice

The findings of the study are suggestive of a variety of interventions, policies, and practices at different ages and at multiple levels that can contribute to the prevention of substance use, progression to abuse, and related behavioral problems. These include early childhood interventions (Manning, Homel, & Smith, 2010; Ou & Reynolds, 2006; Reynolds et al., 2007; Schweinhart et al., 2005) and parenting programs (Sweet & Appelbaum, 2004; Webster-Stratton & Taylor, 2001), home visiting programs to prevent child maltreatment (Reynolds, Mathieson, & Topitzes, 2009), social skills training to strengthen peer relationships and resistance skills (Hawkins et al., 2005; Botvin et al., 2001), and school-based programs to reduce mobility, coordinate services, and provide continuity in learning environments (Finn-Stevenson & Zigler, 1999; Takanishi & Kauerz, 2008; Titus, 2007), and youth mentoring (Rhodes & DuBois, 2006). Unfortunately, most programs to prevention substance use and related problems are implemented too late to be effective. The most cost-effective programs and those likely to have enduring effects are usually implemented prior to adolescence and follow established principles of effectiveness (Nation et al., 2003; Reynolds & Temple, 2008).

More broadly, multi-component programs that are implemented relatively early in the life course and have sufficient duration, scope, and intensity are most likely to be effective not only for the prevention of substance abuse but the promotion of well-being in education, social behavior, health, and mental health. Given the breadth of predictors of substance abuse found in this study and others, collaboration across education and human service systems in the development and implementation of programs and policies also may provide unique opportunities to improve the health and well-being of young people in more enduring and sustainable ways.

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Appendix

Appendix A

Descriptive statistics of the model variables before and after imputations

Variable	Before imputation			After imputation (n=1,208)		
	Obs	Mean	Std. Dev.	Mean	Std. Dev.	
Child protection services (ages 4-9)	1140	0.103	0.304	0.097	0.296	
Family conflict (ages 5-10)	1142	0.058	0.233	0.061	0.240	
Parent substance abuse experience (ages 5-10)	1142	0.041	0.199	0.046	0.209	
School mobility (ages 6-9)	1152	0.740	0.871	0.741	0.851	
Social maturity (ages 7-9)	1142	19.324	4.829	19.311	4.709	
Family risk (age 8)	1142	4.067	1.856	4.230	1.791	
Parent expectations (ages 8-10)	1072	3.388	0.872	3.388	0.872	
Intrinsic motivation (ages 9-10)	985	-0.017	0.870	-0.014	0.786	
No trouble- making behavior (ages 9-12)	1077	6.062	1.863	6.064	1.763	
Reading achievement (age 10)	1007	102.906	15.884	102.833	14.664	
School mobility (ages 10-13)	1102	0.959	0.976	0.965	0.989	
School quality (ages 10-14)	1103	0.130	0.336	0.129	0.335	
Parent substance abuse experience (ages 10-15)	1142	0.087	0.282	0.089	0.284	
Personal substance use experience (ages 10-15)	1142	0.028	0.165	0.031	0.175	
School mobility (ages 14-18)	698	0.385	0.487	0.393	0.489	
Negative peer affiliation (age 16)	1142	0.037	0.188	0.031	0.175	
School dropout (by age 16)	1168	0.124	0.330	0.125	0.331	

Note. Imputations based on the expectation-maximization method. The selection variables included children's gender, family demographic characteristics, kindergarten school, and CPC preschool participation. See text for further information.

Appendix B

Correlation Matrix (values of 0.06 and above in absolute value are significant at $p < 0.05$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 Female	1.00																							
2 Black	0.03	1.00																						
3 CPC preschool participation	0.08	0.01	1.00																					
4 Child protection services (ages 4-9)	0.00	-0.01	-0.02	1.00																				
5 Family conflict (ages 5-10)	-0.04	-0.02	-0.01	0.09	1.00																			
6 Parent substance abuse experience (ages 5-10)	-0.03	-0.03	0.02	0.12	0.34	1.00																		
7 School mobility (ages 6-9)	-0.05	0.04	-0.05	0.12	0.00	0.03	1.00																	
8 School-age CPC participation (ages 6-9)	0.03	0.03	0.37	-0.01	0.03	0.00	-0.27	1.00																
9 Social maturity (ages 7-9)	0.27	-0.06	0.16	-0.08	0.01	0.03	-0.13	0.12	1.00															
10 Family risk (age 8)	0.01	0.05	-0.05	0.15	0.02	0.03	0.19	-0.01	-0.20	1.00														
11 Parent expectations (ages 8-10)	0.17	-0.07	0.14	-0.17	-0.03	0.02	-0.13	0.11	0.61	-0.28	1.00													
12 Intrinsic motivation (ages 9-10)	0.08	-0.02	0.00	-0.01	-0.02	0.03	-0.02	-0.01	0.07	0.03	0.07	1.00												
13 No trouble making behavior (ages 9-12)	0.15	0.03	0.10	-0.04	-0.04	-0.04	-0.10	0.08	0.19	-0.13	0.08	0.12	1.00											
14 Reading comprehension (age 10)	0.20	-0.06	0.18	-0.05	0.07	0.05	-0.11	0.13	0.56	-0.28	0.43	0.00	0.16	1.00										
15 School mobility (ages 10-15)	-0.09	-0.02	-0.17	0.109	0.071	0.049	0.176	-0.16	-0.18	0.17	-0.21	-0.03	-0.13	-0.19	1.00									
16 School quality (ages 10-14)	0.07	0.01	0.16	-0.06	-0.01	-0.01	-0.13	0.13	0.09	-0.18	0.14	0.02	0.10	0.24	-0.17	1.00								
17 Parent substance abuse experience (ages 10-15)	-0.02	0.00	0.07	0.14	0.14	0.53	0.06	0.00	0.05	0.00	0.02	0.03	0.00	0.09	0.02	-0.02	1.00							
18 Personal substance use experience (ages 10-15)	-0.15	0.01	-0.04	0.10	0.19	0.19	0.04	-0.02	-0.06	0.06	-0.03	-0.04	-0.05	-0.05	0.06	-0.06	0.23	1.00						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
19 School mobility (ages 14-18)	-0.05	0.06	-0.02	0.02	0.02	-0.03	0.04	-0.05	-0.11	0.08	-0.12	-0.01	-0.05	-0.14	0.09	-0.08	0.00	0.03	1.00					
20 Deviant peer affiliation (ages 16)	0.01	-0.01	-0.01	-0.02	0.06	-0.01	0.02	0.00	-0.02	0.00	-0.03	-0.02	-0.03	0.03	0.03	0.00	-0.01	0.03	0.04	1.00				
21 School dropout (by age 16)	-0.11	-0.04	-0.07	0.10	0.09	0.09	0.00	-0.03	-0.12	0.07	-0.14	0.00	-0.04	-0.07	0.15	-0.05	0.06	0.05	-0.09	0.04	1.00			
22 Age of first substance use	-0.10	0.04	0.04	-0.16	-0.05	-0.08	-0.08	0.02	0.00	-0.14	0.03	-0.04	0.00	0.02	0.03	0.09	-0.04	-0.16	-0.10	-0.05	-0.11	1.00		
23 Substance abuse	-0.47	0.01	-0.09	0.13	0.10	0.12	0.03	-0.01	-0.24	0.07	-0.22	-0.09	-0.17	-0.19	0.22	-0.10	0.10	0.25	0.10	0.08	0.13	0.21	1.00	
24 Drug dependency	-0.21	0.11	-0.03	0.06	0.15	0.10	-0.05	-0.07	-0.15	0.04	-0.11	-0.02	-0.14	-0.09	0.11	-0.12	0.10	0.34	0.08	-0.03	0.03	-0.04	0.39	1.00

Appendix C

Factors Predicting Substance Dependency (Dichotomous specification, n=440)

	All				Male			
	Marginal effect	Std. Err.	z	P>z	Marginal effect	Std. Err.	z	P>z
Female	-0.256	0.045	-5.130	0.000				
Black	0.267	0.075	2.540	0.011	0.292	0.098	2.290	0.022
CPC preschool participation (ages 3-4)	0.003	0.055	0.050	0.963	-0.013	0.060	-0.220	0.829
Child protection services (ages 4-9)	0.047	0.070	0.670	0.502	0.059	0.105	0.560	0.573
Family conflict (ages 5-10)	0.263	0.083	3.090	0.002	0.249	0.108	2.190	0.028
CPC school age participation (ages 6-9)	-0.063	0.063	-1.010	0.312	-0.081	0.075	-1.080	0.279
Social maturity (ages 7-9)	-0.009	0.006	-1.540	0.124	-0.013	0.008	-1.550	0.120
Family risk (age 8)	-0.007	0.014	-0.490	0.621	-0.004	0.016	-0.270	0.790
Parent expectations (ages 8-10)	0.006	0.035	0.170	0.868	0.032	0.048	0.660	0.509
Intrinsic motivation (ages 9-10)	0.019	0.033	0.570	0.571	0.011	0.044	0.240	0.810
Reading achievement (age 10)	0.001	0.001	0.800	0.425	0.002	0.002	1.130	0.257
No trouble-making behavior (ages 9-12)	-0.036	0.016	-2.190	0.029	-0.038	0.020	-1.930	0.054
School quality (ages 10-14)	-0.164	0.094	-1.520	0.129	-0.152	0.117	-1.210	0.227
School mobility (ages 14-18)	0.050	0.047	1.070	0.282	0.055	0.054	1.020	0.310
Parent substance abuse experience (ages 10-15)	0.165	0.072	2.330	0.020	0.123	0.067	1.840	0.065
Deviant peer affiliation (age 16)	-0.016	0.049	-0.330	0.739	-0.012	0.066	-0.180	0.854
School dropout (by age 16)	0.008	0.065	0.120	0.903	0.002	0.064	0.020	0.980
Wald Chi-squared	319.97				250.06			
Prob. > Chi-squared	0.00				0.00			
Pseudo R-squared	0.12				0.08			

Note:

Probit coefficients are transformed to marginal effects (dy/dx), which are the change in substance dependency (in percentage points) per 1-unit change in the explanatory variables.

*** p<0.001

**

* p<0.01

* p<0.05.

Appendix D

Factors Predicting Substance Dependency (Dichotomous specification, n=1208)

	All				Male			
	Marginal effect	Std. Err.	z	P>z	Marginal effect	Std. Err.	z	P>z
Female	-0.176	0.023	-10.82	0.000				
Black	0.068	0.015	2.62	0.009	0.169	0.051	2.32	0.020
CPC preschool participation (ages 3-4)	0.005	0.014	0.36	0.722	0.006	0.035	0.16	0.869
Child protection services (ages 4-9)	0.061	0.030	2.41	0.016	0.109	0.070	1.63	0.102
Family conflict (ages 5-10)	0.127	0.046	3.44	0.001	0.213	0.086	2.64	0.008
CPC school age participation (ages 6-9)	-0.013	0.016	-0.81	0.416	-0.042	0.042	-1.00	0.318
Social maturity (ages 7-9)	-0.003	0.002	-1.44	0.149	-0.008	0.006	-1.44	0.151
Family risk (age 8)	0.000	0.004	-0.11	0.915	0.001	0.010	0.10	0.920
Parent expectations (ages 8-10)	-0.012	0.010	-1.1	0.270	-0.016	0.031	-0.51	0.613
Intrinsic motivation (ages 9-10)	-0.003	0.008	-0.39	0.696	-0.019	0.022	-0.86	0.387
Reading achievement (age 10)	0.000	0.000	-0.22	0.828	0.000	0.001	0.39	0.695
No trouble-making behavior (ages 9-12)	-0.017	0.005	-3.49	0.000	-0.034	0.012	-2.99	0.003
School quality (ages 10-14)	-0.056	0.020	-1.89	0.058	-0.119	0.063	-1.54	0.123
School mobility (ages 14-18)	0.027	0.014	1.95	0.051	0.074	0.035	2.06	0.040
Parent substance abuse experience (ages 10-15)	0.075	0.029	3.22	0.001	0.093	0.050	2.07	0.039
Deviant peer affiliation (age 16)	0.023	0.015	1.61	0.108	0.047	0.041	1.15	0.248
School dropout (by age 16)	0.017	0.024	0.74	0.459	0.018	0.045	0.39	0.693
Wald Chi-squared	1836.46				655.15			
Prob. > Chi-squared	0.00				0.00			
Pseudo R-squared	0.24				0.11			

Note:

Probit coefficients are transformed to quantify marginal effects of the selected independent variables on the probability of outcomes.

*** p<0.001

**

* p<0.01

* p<0.05.

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Table 1**Background Characteristics for the Original and Study Samples**

Variable	Original sample (n=1,531)		Study sample (n=1,208)	
	Mean	Std. Dev.	Mean	Std. Dev.
Child is female	0.502	0.500	0.516	0.500
Child is Black	0.930	0.256	0.938	0.241
Mother was younger than age 18 at child's birth *	0.167	0.373	0.172	0.377
School neighborhood with >60% low income *	0.760	0.427	0.760	0.427
CPC preschool participation (ages 3-4)	0.643	0.479	0.646	0.479
Child protection services (ages 4-9)	0.098	0.298	0.097	0.296
ITBS word analysis scores (age 6)	63.770	13.300	64.343	13.316
ITBS math scores (age 6)	56.666	14.825	57.228	14.752
CPC school-age participation (ages 6-9)	0.552	0.497	0.565	0.496
Mother is a single parent (age 8) *	0.608	0.488	0.594	0.491
Four or more children in family (age 8) *	0.323	0.468	0.329	0.470
Mother did not complete high school (age 8) *	0.440	0.497	0.436	0.496
Mother is not employed (age 8) *	0.524	0.500	0.519	0.500
Child eligible for fully subsidized lunches (age 8) *	0.833	0.373	0.836	0.370
Mother received AFDC (age 8) *	0.600	0.490	0.587	0.493
Family risk (age 8)	4.250	1.792	4.230	1.791

Note. Of the original sample of 1,539, 8 participants had insufficient information and were excluded from these statistics. ITBS = Iowa Tests of Basic Skills (end of kindergarten).

CPC = Child-Parent Center program.

* included in the family risk index (family risk), which is a sum of 8 dichotomous indicators.

Table 2

Descriptive Statistics of Explanatory and Outcome Variables (n=1,208)

Variable	Mean	Std. Dev.	Min	Max
Demographic characteristics				
Gender (female)	.52	.50	0	1
Race/ethnicity (African-American)	.94	.24	0	1
Early and middle childhood factors				
CPC preschool participation (ages 3-4)	.65	.48	0	1
Child protection services (ages 4-9)	.10	.30	0	1
Family conflict (ages 5-10)	.06	.24	0	1
Parent substance abuse experience (ages 5-10)	.05	.21	0	1
School mobility (ages 6-9)	.74	.85	0	4
CPC school-age participation (ages 6-9)	.57	.50	0	1
Social maturity (ages 7-9)	19.31	4.71	7	30
Family risk (age 8)	4.23	1.79	0	8
Parent expectations (ages 8-10)	3.39	.87	1	5
Intrinsic motivation (ages 9-10)	-.01	.79	-3.2	1.7
No trouble-making behavior (ages 9-12)	6.06	1.76	1	12
Reading achievement (age 10)	102.83	14.66	53	150
Adolescence factors				
School mobility (ages 10-14)	.97	.99	0	4
School quality (ages 10-14)	.13	.34	0	1
Parent substance abuse experience (ages 10-15)	.09	.28	0	1
Personal substance use experience (ages 10-15)	.03	.17	0	1
School mobility (ages 14-18)	.21	.48	0	3
Deviant peer affiliation (age 16)	.39	.49	0	1
School dropout (by age 16)	.13	.33	0	1
Outcomes				
Age of first substance use	17.21	3.20	9	26
Substance abuse	.26	.44	0	1
Substance dependency (among those with use) ^a	.38	.49	0	1

Variable	Mean	Std. Dev.	Min	Max
Length of time from use to dependency (in years) ²	5.49	2.97	3	16

CPC = Child-Parent Center program

¹ Dichotomous variable that takes a value of 1 if the individual was classified as drug dependent and 0 otherwise (sample size is 440).

² Information was available for one-year, two-year or four-year periods. When a participant satisfied the definition for dependency, he/she was classified as substance dependent for the whole period (e.g. 4 years). The sample size for length of time from use to dependency includes only participants who were classified as substance dependent (n=168).

Table 3

Age of First Substance Use

Age of first substance use	Frequency	Percent	Cumulative Percent
0	768	63.6%	63.6%
Less than 10	3	0.2%	63.8%
10	3	0.2%	64.1%
11	3	0.2%	64.3%
12	5	0.4%	64.7%
13	6	0.5%	65.2%
14	55	4.6%	69.8%
15	74	6.1%	75.9%
16	49	4.1%	80.0%
17	54	4.5%	84.4%
18	46	3.8%	88.2%
19	41	3.4%	91.6%
20	26	2.2%	93.8%
21	28	2.3%	96.1%
22	20	1.7%	97.8%
23	15	1.2%	99.0%
24	5	0.4%	99.4%
25	5	0.4%	99.8%
26	2	0.2%	100.0%

Note. Participants with no substance use are coded 0.

Table 4

Factors Predicting the Incidence of Substance Abuse by Age 26

	Total sample (n=1,208)				Male group (n=585)			
	Marginal effect	Robust Std.Error	p-value		Marginal effect	Robust Std. Error	p-value	
Gender (female)	-0.350	0.025	0.000	***				
Race/ethnicity (African-American)	0.060	0.033	0.151		0.080	0.071	0.322	
CPC preschool participation (ages 3-4)	-0.010	0.023	0.509		-0.030	0.035	0.303	
Child protection services (ages 4-9)	0.170	0.057	0.000	***	0.220	0.067	0.002	**
Family conflict (ages 5-10)	-0.010	0.041	0.943		-0.020	0.076	0.873	
Parent sub abuse experience (ages 5-10)	-0.030	0.059	0.687		-0.060	0.137	0.689	
School mobility (ages 6-9)	-0.030	0.017	0.098		-0.040	0.028	0.211	
CPC school-age participation (ages 6-9)	0.040	0.032	0.219		0.050	0.042	0.283	
Social maturity (ages 7-9)	0.000	0.004	0.896		0.000	0.006	0.573	
Family risk (age 8)	0.000	0.006	0.752		0.000	0.014	0.874	
Parent expectations (ages 8-10)	-0.050	0.021	0.012	*	-0.060	0.035	0.075	
Intrinsic motivation (ages 9-10)	-0.020	0.018	0.181		-0.040	0.030	0.270	
No trouble-making behavior (ages 9-12)	-0.030	0.006	0.000	***	-0.040	0.011	0.000	***
Reading achievement (age 10)	0.000	0.001	0.345		0.000	0.002	0.390	
School mobility (ages 10-14)	0.030	0.016	0.060		0.060	0.025	0.016	*
School quality (ages 10-14)	-0.060	0.044	0.237		-0.080	0.081	0.285	
Parent substance abuse experience (ages 10-15)	0.100	0.055	0.037		0.140	0.094	0.150	
Personal substance use experience (ages 10-15)	0.460	0.115	0.000	***	0.400	0.081	0.000	***
School mobility (ages 14-18)	0.040	0.020	0.018	*	0.110	0.045	0.005	**
Deviant peer affiliation (age 16)	0.080	0.025	0.002	**	0.130	0.048	0.006	**
School dropout (by age 16)	0.030	0.032	0.218		0.020	0.050	0.575	
Wald Chi-squared	2,968.73				2,207.66			
Prob. > Chi-squared	0.00				0.00			
Pseudo R-squared	0.33				0.16			

Note:

Probit coefficients are transformed to marginal effects (dy/dx), which are the change in substance abuse (in percentage points) per 1-unit change in the explanatory variables.

p<0.001
**
p<0.01
*
p<0.05.

Table 5

Factors Predicting Age of First Substance Use

	All				Males			
	Hazard Ratio	Std. Err.	z	P>z	Hazard Ratio	Std. Err.	z	P>z
Female	1.132	0.140	1.010	0.314				
Black	0.735	0.104	-2.170	0.030 *	0.732	0.121	-1.880	0.060
CPC preschool participation (ages 3-4)	0.867	0.086	-1.450	0.148	0.891	0.101	-1.020	0.309
Child protection services (ages 4-9)	1.394	0.167	2.780	0.005 **	1.407	0.204	2.360	0.018 *
Family conflict (ages 5-10)	1.203	0.169	1.310	0.189	1.353	0.226	1.810	0.070
School mobility (ages 6-9)	1.044	0.056	0.800	0.426	0.998	0.061	-0.020	0.980
CPC school-age participation (ages 6-9)	1.027	0.099	0.280	0.781	1.038	0.120	0.320	0.747
Social maturity (ages 7-9)	1.005	0.011	0.440	0.662	1.005	0.013	0.420	0.675
Family risk (age 8)	1.055	0.029	1.960	0.050 *	1.067	0.035	2.000	0.046 *
Parent expectations (ages 8-10)	1.034	0.062	0.550	0.579	0.932	0.065	-1.010	0.314
Intrinsic motivation (ages 9-10)	1.056	0.058	1.000	0.315	1.060	0.066	0.940	0.349
No trouble-making behavior (ages 9-12)	1.023	0.029	0.820	0.413	1.027	0.031	0.890	0.375
Reading achievement (age 10)	0.999	0.004	-0.240	0.814	1.000	0.004	-0.110	0.914
School mobility (ages 10-14)	1.315	0.096	3.750	0.000 ***	1.257	0.109	2.650	0.008 **
School quality (ages 10-14)	0.820	0.125	-1.300	0.195	0.771	0.139	-1.440	0.150
Parent substance abuse experience (ages 10-15)	0.981	0.145	-0.130	0.898	0.832	0.155	-0.990	0.324
Deviant peer affiliation (age 16)	1.098	0.095	1.080	0.279	1.095	0.109	0.910	0.362
Wald Chi-squared	41.64				32.71			
Prob. > Chi-squared	0.00				0.0081			

Note:

*** p<0.001

** p<0.01

* p<0.05.

Table 6

Factors Predicting Substance Dependency

	Haz. Ratio	Std. Err.	z	P>z	Haz. Ratio	Std. Err.	z	P>z
Female	0.287	0.077	-4.68	0.000 ***				
Black	2.235	1.438	1.25	0.212	1.950	1.021	1.28	0.202
CPC preschool participation (ages 3-4)	0.800	0.129	-1.39	0.166	0.823	0.159	-1.01	0.312
Child protection services (ages 4-9)	1.833	0.379	2.93	0.003 **	1.600	0.337	2.23	0.025 *
Family conflict (ages 5-10)	1.682	0.433	2.02	0.044 *	2.014	0.432	3.26	0.001 **
CPC school age participation (ages 6-9)	0.914	0.178	-0.46	0.644	0.909	0.172	-0.50	0.615
Social maturity (ages 7-9)	0.973	0.012	-2.16	0.031 *	0.967	0.020	-1.60	0.110
Family risk (age 8)	1.018	0.060	0.30	0.762	1.045	0.050	0.91	0.364
Parent expectations (ages 8-10)	1.025	0.129	0.20	0.843	1.037	0.120	0.31	0.757
Intrinsic motivation (ages 9-10)	1.087	0.096	0.95	0.343	1.040	0.100	0.41	0.683
Reading achievement (age 10)	1.001	0.005	0.21	0.831	0.962	0.052	-0.71	0.479
Trouble-making behavior (ages 9-12)	0.972	0.052	-0.52	0.600	1.002	0.007	0.33	0.738
School quality (ages 10-14)	0.493	0.202	-1.73	0.084 +	0.582	0.216	-1.46	0.145
School mobility (ages 14-18)	1.447	0.226	2.37	0.018 *	1.121	0.286	0.45	0.655
Parent substance abuse experience (ages 10-15)	1.754	0.587	1.68	0.093 +	1.417	0.229	2.16	0.031 *
Deviant peer affiliation (age 16)	1.213	0.236	0.99	0.320	1.107	0.192	0.59	0.557
School dropout (by age 16)	1.518	0.317	2.00	0.046 +	1.458	0.347	1.58	0.113
Wald Chi-squared	116.200				50.340			
Prob. > Chi-squared	0.000				0.000			

Note:

p<0.001**
p<0.01*
p<0.05