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Effects of Prenatal Cocaine Exposure on Special Education in School-Aged Children

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Abstract

OBJECTIVE—The objective of this study was to evaluate the effects of prenatal cocaine exposure on special education at age 7 with adjustment for covariates.

METHODS—As part of the prospective, longitudinal, multisite study of children with prenatal cocaine exposure (Maternal Lifestyle Study), school records were reviewed for 943 children at 7 years to determine involvement in special education outcomes: (1) individualized education plan; (2) special education conditions; (3) support services; (4) special education classes; and (5) speech and language services. Logistic regression was used to examine the effect of prenatal cocaine exposure on these outcomes with environmental, maternal, and infant medical variables as covariates, as well as with and without low child IQ.

RESULTS—Complete data for each analysis model were available for 737 to 916 children. When controlling for covariates including low child IQ, prenatal cocaine exposure had a significant effect on individualized education plan. When low child IQ was not included in the model, prenatal cocaine exposure had a significant effect on support services. Male gender, low birth weight, white race, and low child IQ also predicted individualized education plan. Low birth weight and low child IQ were significant in all models. White race was also significant in speech and language services. Other covariate effects were model specific. When included in the models, low child IQ accounted for more of the variance and changed the significance of other covariates.

CONCLUSIONS—Prenatal cocaine exposure increased the likelihood of receiving an individualized education plan and support services, with adjustment for covariates. Low birth weight and low child IQ increased the likelihood of all outcomes. The finding that white children were more likely to get an individualized education plan and speech and language services could indicate a greater advantage in getting educational resources for this population.

Keywords

prenatal exposure; cocaine; education; schools

Increased use of cocaine in the United States in the 1980s turned the scientific community toward studying the children of mothers who used cocaine during pregnancy. Initial legal and social stigma attached to mothers who abused cocaine during pregnancy and their “crack kids” who were feared to be “brain damaged”^{1,2} has been tempered by evidence that the risk for serious congenital malformations or medical complications in newborns with prenatal cocaine exposure (PCE) is minimal³; however, little is known about the potential long-term neurodevelopmental effects of PCE. Previous studies revealed varying effects of PCE on behavior^{4–6} and cognitive outcomes.^{7–13} Longitudinal follow-up studies of the intelligence of these children suggested that cocaine effects are apparent but more subtle than originally feared.¹⁴ Inconsistencies in the cocaine literature have been described and may be attributable to methodologic issues such as small sample size; confounding of cocaine exposure with exposure to other drugs; lack of biochemical verification for exposure status and levels; and lack of adequate control for demographic variables such as prenatal care, socioeconomic status (SES), and out-of-home placement.^{14,15}

There are few studies of school function in children with PCE. Teacher rating of school behavior suggested increased behavior problems in children with PCE in some^{5,6,16} but not all studies.¹⁷ Studies have reported adverse effects of PCE on language in children aged 2.5 to 9.5 years,^{14,18–24} whereas others have not^{25,26}; however, there are no studies of use of school-based speech and language services in this group. One study of school performance showed no effects of PCE on grade progression, grade point average, or standardized test.²⁷ We provide the first report of enrollment in special education of children with PCE. These services require significant school funding and teacher resources. On the basis of these findings, we hypothesized that PCE is associated with higher rates of enrollment in special education and the need for support services at 7 years, especially speech and language services.

METHODS

The Maternal Lifestyle Study is a large, multisite, longitudinal investigation of PCE being conducted at 4 geographically diverse, collaborating university centers (Wayne State University, University of Tennessee at Memphis, University of Miami, and Brown University). Each participating center had approval for the study from the institutional review board and a certificate of confidentiality from the National Institute on Drug Abuse. Informed consent was obtained from all participants.

Between May 1993 and May 1995, mothers at these centers were enrolled in the study within 24 hours after delivery.^{3,28,29} Initial screening included the mother’s labor and delivery chart, the newborn admission chart, and a meconium sample. A drug use questionnaire that addressed the mother’s use of nicotine, alcohol, marijuana, cocaine, opiates, and other illicit drugs was given by research staff who were trained and certified in the reliable administration of all of the study interviews. Exposure was determined on the basis of a mother’s admitting cocaine use during pregnancy and/or a positive meconium assay for cocaine metabolites including gas chromatography/mass spectrometry confirmation. Nonexposed children were those who were born to mothers who denied cocaine use, confirmed by negative meconium test results. As previously reported,³⁰ participants for the longitudinal follow-up were recruited at a 1-month visit. The sample included a cohort of exposed infants ($n = 658$) who were group matched within site with a

group of nonexposed comparison children ($n = 730$) by gestational age categories (<32, 33–36, and >36 weeks) and child gender, race, and ethnicity. At the 1-month visit, the biological mother was interviewed for a detailed inventory of her legal and illegal drug use during pregnancy using the Maternal Interview of Substance Use (MISU). Prenatal cocaine use was categorized as high, some, or none on the basis of standard criteria.³¹ “High” cocaine use referred to ≥ 3 times per week in the first trimester. Any other use was referred to as “some” cocaine use. MISU reports of the frequency and quantity of these substances per trimester were averaged to produce indices of the number of tobacco cigarettes (heavy use: ≥ 10 cigarettes per day), the amount of absolute alcohol (heavy use: ≥ 0.5 oz/day), and the number of marijuana joints (heavy use: ≥ 0.5 joints per day) consumed during the pregnancy.

Measures

Medical characteristics were collected at birth (Table 1).

Demographics—Parent/caregiver age, race, marital status, education level, and Medicaid insurance status were collected at 1 month.

Maternal/Caregiver IQ—Maternal/caregiver IQ was measured with the Peabody Picture Vocabulary Test at 30 months or 5 years.

Postnatal Substance Use—Postnatal substance use was measured at 4 months, 8 months, then yearly using the Caretaker Inventory of Substance Use, which quantifies frequency and amounts of cocaine, opiates, marijuana, tobacco, and alcohol with the same indices for heavy use as the MISU.

Socioeconomic Status—SES was measured with the Hollingshead Index of Social Position^{32,33} at 1 month, then yearly.

Home—Quality of the home environment was measured with the Home Observation for Measurement of the Environment (HOME)³⁴ at 10 months and 5.5 years.

Depression—Depression was measured with the Beck Depression Inventory, a proxy for caregiver depression assessed at 4 months, 30 months, and 5.5 years.

Domestic Violence—Domestic violence was assessed yearly between 4 and 7 years using a questionnaire (via Caretaker Inventory of Substance Use) on any experience of domestic violence by the caregiver, including physical or sexual abuse.

Child Abuse—Child abuse was defined by removal of the child from the home as a result of suspicion of physical and/or sexual abuse or medical examination findings suggestive of physical or sexual abuse.

Primary Caregiver—Changes in primary caregivers (child with biological mother or other caregiver) were recorded at 1 month, then yearly.

IQ—Child IQ was measured at 7 years using the Wechsler Intelligence Scale for Children III.

School Performance—>Each child’s school performance data were gathered directly from school records at age 7 by research staff who were trained for interrater reliability and included the presence of the following for the current school year: (1) individualized education plan (IEP); (2) special education conditions (SEs) including mental retardation,

learning disabilities, behavioral/emotional impairment, orthopedic impairment, attention-deficit/hyperactivity disorder, speech/language impairment, and physical or other health impairment; (3) special education classes (SECs) including math, language arts, social studies, science, and conduct (work effort, interpersonal skills); (4) support services (SSs) including occupational therapy, physical therapy, speech and language, counseling/behavior management, reading tutoring/assistance, math tutoring/assistance, and gifted and talented enrichment; and (5) speech and language services (SLSs), which include any service or designation from the previous categories that involves speech, language, or reading. All examiners were blind to prenatal and caregiver substance use.

Statistical Methods

One-way analysis of variance and χ^2 were used for continuous and categorical variables, respectively. Logistic regression was used to examine the effect of PCE on 7-year special education outcomes, including the presence of an IEP, SE, SEC, SS, and SLS, controlling for covariates. Covariates included a priori were gender, low birth weight (LBW) (<1500 g), and study site. Additional characteristics were examined in preliminary analyses as candidate covariates (Table 1 and Table 2). Candidate covariates that were correlated with PCE and the outcome measures ($P \leq .10$) were included in the logistic regression analysis. Measures that met this criterion included small for gestational age, defined as gender-specific weight < 10th percentile for gestational age; ethnicity (white versus nonwhite); low SES at 7 years (Hollingshead Index of Social Position level 5); any primary caregiver change (≥ 1); poor quality of the home environment as assessed by using the HOME total averaged at 10 months and 5.5 years and recoded into a dichotomous variable (lowest 20% cutoff); Medicaid insurance status; prenatal tobacco use; low caregiver IQ (<85); caregiver marital status at 1 month; maternal age at birth (in years); caregiver depression as indicated by average Beck Depression Inventory assessed at 4 months, 30 months, and 5.5 years and recoded into a dichotomous variable (score of >17, indicating moderate to severe depression); and any child abuse.

Regressions for each outcome variable used stepwise elimination of the covariates that made the least contribution to the models and had the least effect on other parameters. The eliminated covariates were then added back to the model in a stepwise manner to test for confounding effects. All covariates in the final models were required to have significant contribution ($P < .10$) to the outcomes except for the 3 selected a priori (gender, LBW, and study site).

Two sets of logistic regression analyses were performed: with and without low child IQ (score of <85 on the Wechsler Intelligence Scale for Children III) as a covariate. The IEP evaluation process involves a multi-disciplinary approach³⁵ and often uses several diagnostic tools. Because IQ scores are a predictor of educational achievement and are often reviewed when assessing a student for the necessity of an IEP and other special education services, we thought that it was important to investigate the interactions of the hypothesized cocaine effects with low child IQ on special education.

RESULTS

Retention

Of the 1388 infants (658 PCE/opiate exposed and 730 comparison children) seen at the 1-month visit, 1023 had 7-year school outcome data. Among the 1023 children, 79 were opiate users and 1 had incomplete data and were not included in this study, resulting in a final sample of 943 children. Compared with children who were not included in the study, included children were more likely to be black, have lower SES, be from mothers with lower

IQ, and have less prenatal tobacco exposure (any or heavy; Table 1). In addition, those with 7-year data had a higher percentage of caregivers who had postnatal alcohol (any or heavy) and marijuana use (any or heavy). Included children were also more likely to have a low HOME score and to have lived in environments with domestic violence. There were no significant differences in newborn medical characteristics or child IQ between the 2 groups.

Sample Description According to Prenatal Cocaine Exposure

Children in this study with PCE were more likely than comparison children to be born to families with low SES at 1 month; come from single-caregiver households; be on Medicaid; and have mothers who had less education, lower IQ, and no prenatal care and were older (Table 2). They were also more likely to have prenatal exposure to alcohol (any and heavy), tobacco (any and heavy), and marijuana (any and heavy). They also were exposed to more postnatal cocaine (any and heavy), alcohol (any and heavy), tobacco (any and heavy), and marijuana (any and heavy); had greater probability of primary caretaker change and low SES; and had a greater likelihood of living in a home with domestic violence. Children with PCE were also more likely to be small for gestational age, less likely to be the first born child, and more likely to have lower IQ.

Of the 267 mothers who reported prenatal cocaine use, 47.9% reported use during all trimesters, 14.6% during the first and second trimesters only, and 14.6% during the first trimester only. Overall reported use declined progressively over the trimesters (81.3%, 75.4%, and 66.7% in the first, second, and third trimesters, respectively) as did heavy use (23.1%, 16.8%, and 11.8%, respectively), whereas some use remained relatively constant (31.7%, 33.9%, and 32.4%, respectively). These trends are similar to those reported previously.³⁰ Of 92 women who reported heavy use in the first trimester, 22.8% continued heavy use in the first 2 trimesters and 32.6% continued heavy use throughout all 3 trimesters. Of 126 who reported some use during the first trimester, 50% continued throughout all 3 trimesters.

Special Education Outcomes

In unadjusted logistic regression analysis, children with PCE (16.5%) were more likely than children in the comparison group (11%) to have an IEP (odds ratio: 1.599 [95% confidence interval: 1.091–2.344]; $P = .016$). There were no effects of PCE on SEs, SSs, SECs, or SLSs.

Complete data for each outcome model controlling for covariates were available for 737 to 916 children. Logistic regression analyses with low child IQ as a covariate (Table 3) showed that children with PCE were more likely to have an IEP. Increased likelihood of an IEP was also related to male gender, LBW, white race, low child IQ, and site. No PCE effect was found on SEs, SSs, SECs, and SLSs. LBW and low child IQ were consistently related to the presence of all outcomes. Site was related to all outcomes except SECs. White race was associated with more SLSs.

In logistic regression analyses without low child IQ as a covariate (Table 3), PCE increased the likelihood of SSs but not IEPs, SEs, SECs, or SLSs. Having an IEP was related to male gender, LBW, white race, low caregiver IQ, low HOME score, and changes in caregiver. SEs were predicted by male gender, LBW, low HOME score, and site. Along with PCE, SSs were related to male gender, LBW, low HOME score, and site. SECs were predicted by LBW and low caregiver IQ. Increased SLSs were related to male gender, LBW, low HOME score, and site.

Our preliminary, univariate analyses did not find any correlations between the levels of prenatal cocaine use and any special education outcomes. We further tested the effect of

heavy prenatal cocaine by controlling for the effects of heavy prenatal tobacco, alcohol, and marijuana use, as well as the dosage-response effects of these drugs (number of cigarettes per day, number of absolute alcohol drinks per day, and number of marijuana joints per day); however, no significant effects of heavy cocaine use were found.

DISCUSSION

PCE and Special Education Outcomes

We found that PCE increased the risk for receiving an IEP and SS with adjustment for covariates. Our findings compliment previously reported deficits in intelligence^{7,14,36–39} and component academic skills, including learning disabilities, poor sustained attention, visual-motor integration and visuospatial memory, and more disorganized and less abstract thinking in this population^{5,36,38,40–46} and suggest that these deficits generalize to the school setting. The rate of services received through IEPs for both those with PCE (16.5%) and comparison children (11%) was significantly higher than the national average of 6.8% in 2003 for children in kindergarten through third grade,⁴⁷ reflecting the high-risk nature of this sample and their need for continued educational services.

The cocaine effect on IEPs was observed with IQ in the model in addition to other covariates, indicating that the IEP referral was not simply attributable to lower IQ in children with PCE. The cocaine effect on SSs was observed without but not with IQ in the model, suggesting that in this case, IQ could mediate the effects of PCE on SSs. Conversely, children with PCE were not more likely to receive SE, SEC, or SLS services. This could suggest that the effects of PCE on school function are not in specific academic domains. These children may need more special education services in general but not any specific type of service. We had expected more SLS referrals for the PCE children on the basis of previous work^{14,18–24}; however, within the IEP group, 95.3% of the PCE group and 91.4% of comparison children also had SLSs, indicating that SLSs are a major area of recognized resource necessity in special education for this population regardless of PCE.

Effects of Other Covariates

LBW was a consistent predictor of all special education outcomes in all models. This supports previous work suggesting that LBW is associated with multiple, adverse neurodevelopmental outcomes, including increased need for special education.⁴⁸ Similarly, that low child IQ was a predictor of all outcome models is to be expected, because IQ is often used in the assessment of special education. In addition, in all models, the inclusion of IQ explained a greater percentage of the variance and significantly changed the contributions of the other covariates (Table 3). Factors such as caregiver IQ, HOME score, and caregiver change were statistically significant only when IQ was excluded from the models, possibly suggesting complex interactions among intelligence, environmental, and genetic factors.^{49,50} For example, a problematic, highly stressed home environment can adversely affect IQ scores, and low child IQ scores could mediate the effects of poor home functioning on special education outcomes.

We also found that boys were more likely to receive an IEP than girls, supporting previous reports.⁴⁷ Male gender also increased the likelihood of receiving SEs, SSs, and SLSs when IQ was not included in the models. This could be explained by the significantly greater percentage of boys (56.6%) versus girls (43.4%) in the low child IQ group ($P = .03$).

Our study also indicates that white race increases the likelihood of having an IEP and SLS, independent of other factors, including low SES and low child IQ. On closer inspection, we found that white students were more likely to receive an IEP at the Detroit site than nonwhite students (29% versus 11.9%; $P = .007$). This finding may also help to explain site

effects (Table 3). None of the other sites had statistically significant differences in rates of IEPs or SLSs in white versus nonwhite samples. Enrollment in private versus public school was not a factor in IEPs or SLSs, because only 3 students with IEPs and 4 with SLSs were enrolled in private school. That race plays a role in determining special education services either as a proxy for other factors or as a causal factor requires additional investigation.

Study Limitations

There are several limitations to this study. First, the data are based on school record review. Although our staff was trained in how to abstract the data, we cannot verify the accuracy of records. Second, the data were gathered from several schools in 4 different states that may have had different thresholds for enrollment in special education. Although federal legislation mandates that each school must provide appropriate services for each child with a disability,³⁵ states and school systems have flexibility about information that they require in an IEP. There is state-to-state variation on documentation of standards and assessments on IEP forms, including differences between the states included in this study.⁵¹ These forms are a primary source of information to guide decisions during IEP team meetings. Ultimately, a group of qualified professionals and the parents look at the child's evaluation results and together decide whether the child is a "child with a disability," as defined by Individuals With Disabilities Education Act,⁵² which is not a standardized process.

We also recognize that the special education outcomes are correlated; however, we believed that it was important to distinguish specific services because they have different educational implications for each child. Another possible limitation is that mothers were recruited at delivery and could represent a different population than women who are recruited during pregnancy. Although that they were asked to report their drug use over the entire pregnancy could be affected by recall bias, there is evidence that postnatal self-report measures of maternal cocaine use are as effective as antenatal measures in predicting neurobehavioral outcomes.⁵³ Finally, it is possible that we underestimated cocaine effects by adjusting for variables such as low IQ and LBW that are on the "causal pathway" between cocaine and the special education outcomes⁵⁴; however, we believed that it would be too difficult to interpret special education findings without considering these factors.

Policy Implications

These findings have policy implications. There were 4 112 052 births in the United States in 2004⁵⁵; 3.9% of pregnant mothers reported illicit drug use in 2004–2005 in the past month.⁵⁶ Although estimates vary, even a conservative estimate of 45 000 children born with PCE per year would suggest, on the basis of our study, that 12.7% will receive an IEP. Enrollment in special education in the United States costs an additional \$8080 per year per student⁵⁷ compared with nonenrolled students. The risk attributable to cocaine for an IEP is $1.79 - 1.00 = 0.79$ (Table 3). Thus, additional cost per year for special education services as a result of PCE alone would total $45\,000 \text{ cocaine births per year} \times 12.7/100 \text{ (baseline IEP rate)} \times 0.79 \text{ (excess risk attributable to cocaine)} \times \$5918 \text{ (additional cost per child)} = \$26\,718\,882$. This yearly cost would then have to be multiplied by the number of years the child receives special education services in school. "Investing" in early intervention might not only relieve long-term suffering in these children but also be cost-effective.

Illicit drugs, such as cocaine, may not be the only prenatal exposures that lead to an increased use of special education resources. Legal substances such as tobacco and alcohol, which were controlled in our study, may have effects on these outcomes. Findings of special education use in children with prenatal alcohol exposure but not fetal alcohol syndrome (comparable to our study children) have varied.^{58–60} We found no studies that examined the

effects of prenatal tobacco use on special education outcomes. These are important areas for future investigation.

What's Known on This Subject

Previous studies have reported deficits in intelligence, academic skills, language, sustained attention, visual motor integration, visuospatial memory, and abstract thinking in children with PCE. Only 1 study has examined school outcomes in this population.

What This Study Adds

No previous studies have examined enrollment in special education in this population, which is vulnerable to cognitive and academic problems. We studied this in a large, prospective, multisite study that examined neurodevelopmental outcomes in children with PCE.

Abbreviations

PCE	prenatal cocaine exposure
SES	socioeconomic status
MISU	Maternal Interview of Substance Use
HOME	Home Observation for Measurement of the Environment
IEP	individualized education plan
SE	special education conditions
SEC	special education classes
SS	support services
SLS	speech and language services
LBW	low birth weight

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TABLE 1

Sample Characteristics According to Attrition

Characteristic	With 7-y Data (n= 943)	Without 7-y Data (n= 445)	P
Maternal characteristics			
Race, n (%)			.000
White	112 (11.9)	108 (24.3)	
Black	769 (81.5)	294 (66.1)	
Hispanic	52 (5.5)	36 (8.1)	
Other	10 (1.1)	7 (1.6)	
Low SES (Hollingshead 5), 1 mo, n (%)	230 (25.2)	79 (18.9)	.010
Marital status, single, n (%)	769 (81.6)	350 (79.0)	.250
Insurance, Medicaid, n (%)	774 (82.1)	357 (80.2)	.410
Education <12y, n (%)	373 (39.6)	172 (38.8)	.780
IQ, mean (SD)	73.00 (17.39)	76.98 (17.06)	.001
No prenatal care, n (%)	107 (11.3)	61 (13.7)	.210
Age, mean (SD), y	28.21 (5.65)	28.63 (6.18)	.210
Prenatal drug use, n (%) ^a			
Cocaine use	398 (42.2)	202 (45.4)	.263
Heavy cocaine use	92 (10.6)	40 (10.4)	.745
Alcohol use	573 (60.8)	252 (56.6)	.140
Heavy alcohol use	119 (12.6)	44 (9.9)	.140
Tobacco use	487 (51.6)	261 (58.7)	.020
Heavy tobacco use	182 (19.3)	112 (25.2)	.013
Marijuana use	213 (22.6)	111 (24.9)	.330
Heavy marijuana use	35 (3.7)	15 (3.4)	.751
Postnatal caregiving environment, n (%)			
Postnatal drug use ^b			
Cocaine use	85 (9.0)	33 (8.6)	.810
Heavy cocaine use	73 (7.8)	20 (5.4)	.138
Alcohol use	684 (72.8)	253 (66.1)	.015
Heavy alcohol use	269 (28.7)	75 (20.4)	.002
Tobacco use	551 (58.6)	241 (62.9)	.150
Heavy tobacco use	369 (39.3)	158 (42.9)	.233
Marijuana use	209 (22.2)	61 (15.9)	.010
Heavy marijuana use	68 (7.2)	12 (3.3)	.007
Caregiver depression	104 (11.1)	35 (10.0)	.570
Low quality of HOME, low 20%	199 (21.6)	46 (14.4)	.005
Primary caregiver change, 1 mo to 7 y	289 (30.7)	132 (30.1)	.840
Low SES (Hollingshead 5), 7 y	164 (17.4)	62 (14.2)	.140

Characteristic	With 7-y Data (<i>n</i> = 943)	Without 7-y Data (<i>n</i> = 445)	<i>P</i>
Child abuse, 1 mo to 7 y	29 (3.1)	15 (3.4)	.770
Domestic violence, 4–7 y	75 (8.0)	15 (3.4)	.002
Newborn medical characteristics and child intelligence			
Gestational age, mean (SD), wk	36.15 (4.08)	36.48 (3.91)	.140
Birth weight, mean (SD), g	2616 (829)	2659 (796)	.360
Length, mean (SD), cm	46.68 (5.10)	46.88 (4.83)	.470
Head circumference, mean (SD), cm	32.06 (3.07)	32.24 (2.95)	.290
LBW, <1500g, <i>n</i> (%)	111 (11.8)	45 (10.1)	.360
SGA, <i>n</i> (%)	221 (23.5)	107 (24.1)	.800
Apgar score, 1 min, median (range)	8 (0–10)	8 (1–10)	.740
Apgar score, 5 min, median (range)	9 (3–10)	9 (1–10)	.350
Male, <i>n</i> (%)	491 (52.1)	236 (53.0)	.740
First born, <i>n</i> (%)	189 (20.0)	109 (24.5)	.060
Child IQ	85.08 (14.80)	87.90 (14.90)	.060
Low child IQ, <85, <i>n</i> (%)	380 (47.6)	50 (43.9)	.460

SGA indicates small for gestational age.

^aHeavy use determined by MISU at 1 month from mothers who reported any use at initial screening.

^bReported by caregiver via Caretaker Inventory of Substance Use at any point from 4 months to 7 years.

TABLE 2

Sample Characteristics According to Cocaine Exposure

Characteristic	PCE (<i>n</i> = 398 [42.2%])	Comparison (<i>n</i> = 545 [57.8%])	<i>P</i>
Maternal characteristics			
Race, <i>n</i> (%)			.270
White	38 (9.5)	74 (13.6)	
Black	334 (83.9)	435 (79.8)	
Hispanic	21 (5.3)	31 (5.7)	
Other	5 (1.3)	5 (0.9)	
Low SES (Hollingshead 5), 1 mo, <i>n</i> (%)	109 (29.1)	121 (22.4)	.020
Marital status, single, <i>n</i> (%)	360 (90.7)	409 (75.0)	.000
Insurance, Medicaid, <i>n</i> (%)	347 (87.2)	427 (78.3)	.000
Education <12y, <i>n</i> (%)	201 (50.5)	172 (31.6)	.000
IQ, mean (SD)	70.98 (15.97)	74.47 (18.22)	.003
No prenatal care, <i>n</i> (%)	87 (21.9)	20 (3.7)	.000
Age, mean (SD), y	30.28 (4.61)	26.70 (5.85)	.000
Prenatal drug use, <i>n</i> (%) ^a			
Cocaine use	398 (100)	—	
Heavy cocaine use	92 (23.1)	—	
Alcohol use	302 (75.9)	271 (49.7)	.000
Heavy alcohol use	92 (23.1)	27 (5.0)	.000
Tobacco use	325 (81.7)	162 (29.7)	.000
Heavy tobacco use	121 (30.4)	61 (11.2)	.000
Marijuana use	162 (40.7)	51 (9.4)	.000
Heavy marijuana use	26 (6.5)	9 (1.7)	.000
Postnatal caregiving environment, <i>n</i> (%)			
Postnatal drug use ^b			
Cocaine use	83 (20.9)	2 (0.4)	.000
Heavy cocaine use	69 (17.4)	4 (0.7)	.000
Alcohol use	313 (78.8)	371 (68.3)	.000
Heavy alcohol use	164 (41.3)	105 (19.4)	.000
Tobacco use	320 (80.6)	231 (42.5)	.000
Heavy tobacco use	203 (51.1)	166 (30.7)	.000
Marijuana use	119 (30.0)	90 (16.6)	.000
Heavy marijuana use	39 (9.8)	29 (5.4)	.009
Caregiver depression	42 (10.7)	62 (11.4)	.720
Low quality of HOME, low 20%	88 (22.2)	111 (20.9)	.600
Primary caregiver change, 1 mo to 7 y	216 (54.4)	73 (13.4)	.000
Low SES (Hollingshead 5), 7 y	97 (24.4)	67 (12.3)	.000
Child abuse, 1 mo to 7 y	16 (4.0)	13 (2.4)	.151

Characteristic	PCE (<i>n</i> = 398 [42.2%])	Comparison (<i>n</i> = 545 [57.8%])	<i>P</i>
Domestic violence, 4–7 y	44 (11.1)	31 (5.7)	.003
Newborn medical characteristics and child intelligence			
Gestational age, mean (SD), wk	36.09 (4.04)	36.19 (4.10)	.700
Birth weight, mean (SD), g	2554 (756)	2661 (876)	.050
Length, mean (SD), cm	46.40 (4.81)	46.88 (5.30)	.160
Head circumference, mean (SD), cm	31.92 (2.84)	32.16 (3.22)	.230
LBW, <1500g, %	46 (11.6)	65 (11.9)	.860
SGA, <i>n</i> (%)	113 (28.5)	108 (19.9)	.002
Apgar score, 1 min, median (range)	8 (7–9)	8 (1–10)	.840
Apgar score, 5 min, median (range)	9 (8–9)	9 (5–10)	.170
Male, <i>n</i> (%)	208 (52.3)	283 (51.9)	.919
First born, <i>n</i> (%)	33 (8.3)	156 (28.6)	.000
Child IQ, mean (SD)	83.63 (14.32)	86.17 (15.08)	.016
Low child IQ, <85, <i>n</i> (%)	179 (52.3)	201 (44.0)	.019

SGA indicates small for gestational age.

^aHeavy use determined by MISU at 1 month from mothers who reported any use at initial screening.

^bReported by caregiver via Caretaker Inventory of Substance Use at any point from 4 months to 7 years.

TABLE 3
Odds Ratio (95% CI) for Factors That Predict Education Outcomes in Logistic Regression Models

Factor	IEP		SE		SS		SEC		SLS	
	With IQ [n=781 [12.7%]]	Without IQ [n=831 [13.8%]]	With IQ [n=781 [13.3%]]	Without IQ [n=898 [14.0%]]	With IQ [n=790 [17.8%]]	Without IQ [n=909 [18.2%]]	With IQ [n=737 [7.6%]]	Without IQ [n=839 [8.1%]]	With IQ [n=784 [17.9%]]	Without IQ [n=916 [17.8%]]
PCE	179 (1.14–2.83)	1.23 (0.77–1.98)	1.49 (0.96–2.32)	1.21 (0.77–1.92)	1.35 (0.91–2.00)	1.49 (1.04–2.12)	1.18 (0.67–2.07)	0.987 (0.589–1.65)	1.13 (0.77–1.68)	1.31 (0.92–1.87)
<i>P</i>	.010	.380	.080	.410	.130	.030	.580	.960	.530	.130
Male gender	1.69 (1.06–2.70)	2.44 (1.57–3.78)	1.48 (0.94–2.32)	2.09 (1.39–3.16)	1.44 (0.97–2.13)	1.62 (1.13–2.33)	1.33 (0.75–2.38)	1.64 (0.97–2.75)	1.42 (0.96–2.10)	1.66 (1.16–2.37)
<i>P</i>	.030	.000	.090	.000	.070	.010	.330	.064	.080	.010
LBW	2.25 (1.22–4.13)	2.58 (1.49–4.48)	2.21 (1.21–4.04)	2.48 (1.46–4.21)	2.42 (1.40–4.20)	2.79 (1.73–4.50)	2.67 (1.36–5.21)	2.75 (1.50–5.05)	1.90 (1.10–3.30)	2.35 (1.46–3.80)
<i>P</i>	.010	.001	.010	.001	.002	.000	.004	.001	.020	.000
SGA	—	—	—	—	—	0.64 (0.40–1.01)	—	—	—	0.67 (0.43–1.06)
<i>P</i>	—	—	—	—	—	.060	—	—	—	.084
White race	2.06 (1.02–4.13)	2.60 (1.36–4.97)	—	1.67 (0.93–3.01)	1.70 (0.94–3.08)	1.57 (0.92–2.69)	—	—	1.90 (1.04–3.46)	1.68 (0.99–2.87)
<i>P</i>	.040	.004	—	.090	.080	.100	—	—	.040	.060
Low caregiver IQ	—	1.37 (1.10–1.69)	—	—	—	—	1.29 (0.96–1.73)	1.40 (1.07–1.84)	—	—
<i>P</i>	—	.004	—	—	—	—	.090	.020	—	—
Caregiver married	—	—	—	—	—	—	—	2.21 (0.91–5.37)	—	—
<i>P</i>	—	—	—	—	—	—	—	.080	—	—
HOMES scale (lowest 20%)	—	1.66 (1.03–2.68)	—	1.82 (1.16–2.87)	—	1.53 (1.02–2.31)	—	—	—	1.83 (1.23–2.72)
<i>P</i>	—	.040	—	.010	—	.040	—	—	—	.003
Any caregiver change	—	1.75 (1.07–2.86)	—	1.50 (0.94–2.40)	—	—	—	—	—	—
<i>P</i>	—	.030	—	.090	—	—	—	—	—	—
Low SES, 7 y	—	—	—	1.54 (0.94–2.52)	—	—	—	—	—	—
<i>P</i>	—	—	—	.090	—	—	—	—	—	—
Low child IQ (<85)	4.99 (2.90–8.59)	—	3.78 (2.31–6.20)	—	2.76 (1.80–4.23)	—	3.55 (1.81–6.97)	—	3.33 (2.17–5.10)	—
<i>P</i>	.000	—	.000	—	.000	—	.000	—	.000	—
Site <i>P</i>	.000	.060	.000	.001	.000	.000	.146	.580	.000	.001
Total <i>R</i> ²	0.199	0.135	0.182	0.125	0.190	0.127	0.129	0.076	0.176	0.111

SGA indicates small for gestational age; —, indicate the factor was not included in the model due to lack of statistically significant correlation ($P < .10$) with the outcome measure.