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# Behavior Problems During Early Childhood in Children With Prenatal Methamphetamine Exposure

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abstract

**BACKGROUND AND OBJECTIVES:** The effects of in utero methamphetamine exposure on behavioral problems in school-aged children are unclear. Our objective for this study was to evaluate behavior problems in children at aged 3, 5, and 7.5 years who were prenatally exposed to methamphetamine.

**METHODS:** Subjects were enrolled in the Infant Development, Environment, and Lifestyle study, a longitudinal prospective study of prenatal methamphetamine exposure and child outcomes. Exposed and comparison groups were matched on birth weight, race, education, and health insurance. At ages 3, 5, and 7.5 years, 339 children (171 exposed) were assessed for behavior problems by using the Child Behavior Checklist. Generalized estimating equations were used to determine the effects of prenatal methamphetamine exposure, age, and the interaction of exposure and age on behavior problems. Caregiver psychological symptoms were assessed by using the Brief Symptom Inventory.

**RESULTS:** Analyses adjusted for covariates revealed that relative to age 3, children at 5 years had less externalizing and aggressive behavior and more internalizing behavior, somatic complaints, and withdrawn behavior. By age 7.5, aggressive behavior continued to decrease, attention problems increased and withdrawn behavior decreased. There were no main effects for methamphetamine exposure and no interactions of exposure and age. Caregiver psychological symptoms predicted all behavior problems and the quality of the home predicted externalizing problems and externalizing syndrome scores.

**CONCLUSIONS:** Behavioral effects longitudinally from ages 3 to 7.5 years were not associated with prenatal methamphetamine exposure, whereas caregiver psychological symptoms and the quality of the home were predictors of behavior problems.



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Dr Chu drafted the initial manuscript and reviewed and revised the manuscript; Ms Dansereau and Ms Roberts conducted the initial analyses and reviewed and revised the manuscript; Drs Smith, Derauf, Newman, Neal, Arria, and Huestis, Ms DellaGrotta, and Dr Lester conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

**WHAT'S KNOWN ON THIS SUBJECT:** Developmental changes in behavioral problems have been found in children aged 3 and 5 with methamphetamine exposure in utero. Early adversity may be a strong determinant of behavioral outcomes for children with methamphetamine exposure in utero.

**WHAT THIS STUDY ADDS:** Longitudinal developmental behavior effects at ages 3, 5, and 7.5 years were not associated with methamphetamine exposure in utero. Caregiver psychological symptoms and the home environment were significant predictors of longitudinal developmental behavior.

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Despite efforts to reduce substance abuse, methamphetamine use in the United States continues to be a problem. The number of current users of methamphetamine among persons aged 12 or older in 2018 was >1.6 million,<sup>1</sup> compared to 353 000 in 2010.<sup>2</sup> Methamphetamine can lead to many health issues for the user, and use during pregnancy may lead to deleterious effects on the developing fetus. Studies in pregnant mice revealed that prenatal methamphetamine exposure led to increased dopamine concentrations in the fetal brain.<sup>3</sup> In addition, animal models using pregnant sheep demonstrated that methamphetamine use during pregnancy produced vasoconstrictive effects, leading to decreased uteroplacental blood flow and fetal hypoxia.<sup>4</sup>

There are few studies focused on the effects of prenatal methamphetamine exposure on developmental outcomes in children. The designs of these studies were mostly cross-sectional. In one previous longitudinal study conducted in Sweden, researchers followed children who were exposed to methamphetamine prenatally and found an association between methamphetamine exposure and increased aggressiveness at ages 4 and 8 years.<sup>5</sup> At ages 10 and 14 years, these children had a higher likelihood of attending 1 grade level lower than their peers at the same age.<sup>6,7</sup> However, these findings were limited by the lack of a control group and a small sample size.

The Infant Development, Environment, and Lifestyle (IDEAL) Study is a prospective, multicenter, longitudinal study designed to assess the effects of prenatal methamphetamine exposure on childhood behavior. Previously reported developmental results of the children at ages 3 and 5 years revealed an interaction effect of increased externalizing and attention-deficit/hyperactivity disorder symptoms at age 5 years with

methamphetamine exposure.<sup>8</sup> In addition, we have reported school-aged findings at age 7.5 years, noting that early adversity significantly mediated the relationship between methamphetamine exposure in utero and childhood behavioral problems.<sup>9</sup> We now report the follow-up data analysis from the IDEAL Study to include the longitudinal behavioral outcomes of children prenatally exposed to methamphetamine at 3 different time points (3, 5, and 7.5 years of age), with careful attention paid to factors leading to adverse behavioral findings. We hypothesized that environmental factors play a role in the effects of prenatal methamphetamine exposure on behavior problems in childhood.

## METHODS

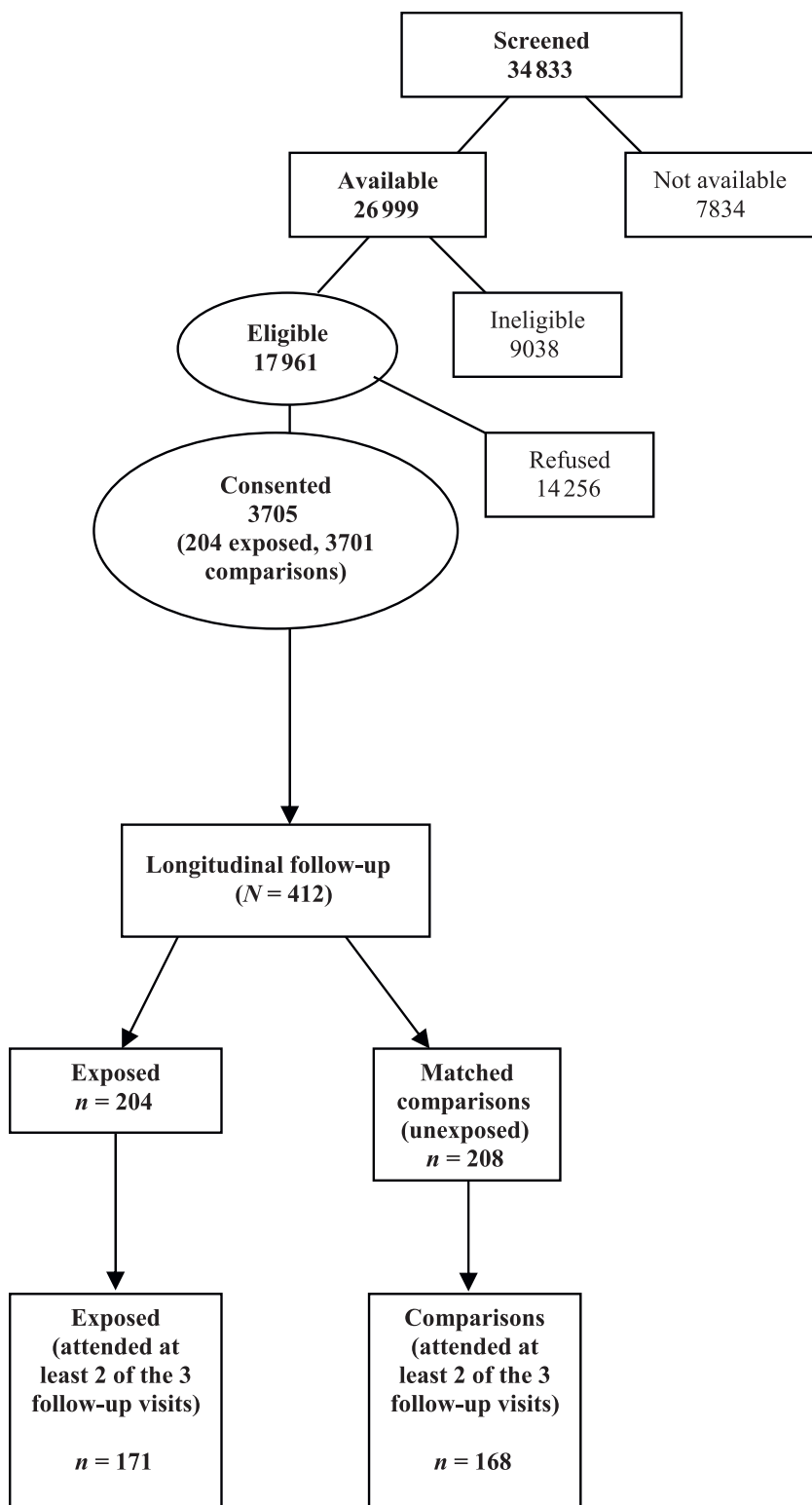
### Study Design

Recruitment for the IDEAL Study occurred at locations where methamphetamine use is known to be a problem; these sites include Los Angeles, California; Des Moines, Iowa; Tulsa, Oklahoma; and Honolulu, Hawaii. The institutional review boards at all participating sites approved the study and informed consent was obtained for all study participants. The recruitment methods of the IDEAL Study were previously described in detail.<sup>10</sup> In brief, meconium samples were obtained from all infants enrolled in the study. Exposure to methamphetamine was defined as a positive meconium screen result by a sensitive enzyme-multiplied immunoassay test and a positive confirmation test result for methamphetamine analyte or its metabolite by gas chromatography–mass spectrometry. Neonates in the nonexposed group had no exposure to methamphetamine and were matched on the basis of race, birth weight category (<1500, 1500–2500, and >2500 g), type of insurance (private

versus public), and education (high school education completed versus not completed). Nonexposure was defined as a negative meconium test result and denial of methamphetamine use during pregnancy. A National Institute on Drug Abuse Certificate of Confidentiality was obtained to ensure the confidentiality of information regarding the mother's drug use, which supersedes mandatory reporting of illegal drug use.

Mothers who were <18 years of age, were institutionalized for retardation or emotional disorders, were overtly psychotic or had a documented history of psychosis, were unable to speak English, or used opiates, lysergic acid diethylamide, phenylcyclohexyl piperidine, hallucinogens, and cocaine during pregnancy were excluded. Exclusion criteria for infants included the following: a major life-threatening congenital anomaly; multiple births; a documented chromosomal abnormality associated with mental or neurologic deficiency; overt toxoplasmosis, other infections (eg, syphilis, varicella-zoster), rubella, cytomegalovirus infection, and herpes simplex infection; a sibling previously enrolled in the IDEAL Study; and infants who were critically ill and unlikely to survive.

A maternal interview using the Lifestyle Interview determined drug use during the pregnancy, and sociodemographic information was determined by using the Four Factor Index of Social Status,<sup>11</sup> an index that ranks socioeconomic status (SES) on the basis of occupation and education. The infants' medical records were reviewed to obtain birth weight, gestational age (GA), and clinical status. GA was determined from the mother's medical chart and was based on the mother's last menstrual period, an early ultrasound, and the clinical examination during prenatal care for those with adequate prenatal



**FIGURE 1**  
The recruitment flowchart details how many participants were screened, were available, were eligible, consented, were enrolled, and were included in the current study.

care. For women with inadequate prenatal care, the postnatal examination by the patient's physician was used for obstetrical dating. These examinations were performed by skilled clinicians trained in these examinations who were blinded to exposure status.

### Subjects

Infants were recruited into the IDEAL Study between September 2002 and November 2004. During this period, 34 833 women were screened for eligibility; 23% were not available for interview. Of the 26 999 women who were approached, 32% were ineligible largely because English was not their primary language. Of those eligible, 23% consented to participate. From this pool of 3705 women who consented to participate, 204 had exposure to methamphetamine. The 204 methamphetamine-exposed infants were matched to 208 non-methamphetamine-exposed infants, and these 412 were enrolled in the study. These infants were followed longitudinally at 3, 5, and 7.5 years of age to assess for differences in behaviors. Subjects who attended at least 2 of the 3 follow-up visits were included in the analysis ( $n = 339$ ) (Fig 1). We have  $>0.90$  power to detect a 0.20 SD difference between the methamphetamine group and the comparison group on the measures of executive function.

### Measures

The Child Behavior Checklist (CBCL) was administered to the parent or primary caregiver at child ages 3, 5, and 7.5 years. At age 3, a majority of children were cared for by their biological or adoptive mothers (71.1%). For the remaining children, the caregiver was unknown (15.0%) or another caregiver (including the biological father, grandparent, aunt, uncle, other relative, or legal guardian; 13.9%). At age 5, children

**TABLE 1** Sample Characteristics by Methamphetamine Exposure

	Exposed ( <i>n</i> = 171)	Comparison ( <i>n</i> = 168)	<i>P</i>
<b>Maternal characteristics</b>			
Race, <i>n</i> (%)			.861
White	63 (36.8)	67 (39.9)	
Hispanic	39 (22.8)	36 (21.4)	
Pacific Islander	32 (18.7)	29 (17.3)	
Asian American	24 (14.0)	23 (13.7)	
Black	7 (4.1)	10 (6.0)	
American Indian	6 (3.5)	3 (1.8)	
Low SES, <i>n</i> (%)	56 (32.7)	17 (10.1)	<.001
Public insurance, <i>n</i> (%)	163 (95.9)	166 (98.8)	.095
No partner, <i>n</i> (%)	96 (56.1)	55 (32.7)	<.001
Education <12 y, <i>n</i> (%)	79 (46.2)	62 (37.1)	.091
Maternal age, y, mean (SD)	25.5 (0.44)	24.7 (0.44)	.191
Prenatal alcohol use, <i>n</i> (%)	62 (36.3)	23 (13.7)	<.001
Prenatal marijuana use, <i>n</i> (%)	54 (31.6)	7 (4.2)	<.001
Prenatal tobacco use, <i>n</i> (%)	139 (81.3)	45 (26.8)	<.001
<b>Neonatal characteristics</b>			
Sex, boy, <i>n</i> (%)	92 (53.8)	87 (51.8)	.710
Birth weight, g, mean (SD)	3184 (47.7)	3281 (44.5)	.140
GA, wk, mean (SD)	38.2 (0.18)	39.0 (0.14)	<.01
<b>Postnatal characteristics</b>			
Any history of primary caretaker change (by 7.5 y), <i>n</i> (%)	110 (65.1)	24 (14.7)	<.001
Postnatal methamphetamine use (by 7.5 y), <i>n</i> (%)	44 (27.7)	6 (3.9)	<.001
Postnatal tobacco use (by 7.5 y), <i>n</i> (%)	108 (65.9)	80 (50.3)	.005
Postnatal alcohol use (by 7.5 y), <i>n</i> (%)	123 (73.7)	131 (81.4)	.095
Postnatal marijuana use (by 7.5 y), <i>n</i> (%)	31 (19.4)	17 (11.2)	.045
Domestic violence (by 7.5 y), <i>n</i> (%)	18 (10.6)	11 (6.6)	.190
Primary caregiver psychological symptoms (1 m, 1 y, and 3 y), BSI average (SD)	0.47 (0.03)	0.47 (0.03)	.913
Quality of home (2.5 and 7 y), HOME average (SD)	40.6 (0.43)	40.4 (0.41)	.680
Reported child abuse (by 7.5 y), <i>n</i> (%)	34 (20)	13 (7.8)	<.01

were cared for by their biological or adoptive mothers (78.1%), an unknown caregiver (10.3%), or another caregiver (11.6%). At age 7.5, children were cared for by their biological or adoptive mothers (74.6%), an unknown caregiver (10.9%), or another caregiver (14.5%). The CBCL for age 1.5 to 5 years was used in this study at the 3- and 5-year visits.<sup>12</sup> The CBCL was administered verbally by trained certified interviewers, and standardized scores of internalizing and externalizing behaviors were generated. At the 7.5-year visit, the CBCL for age 6 to 18 years was used.<sup>13</sup> The CBCL T scores provided a profile of the child's social and behavioral functioning in comparison with children of the same age and sex. More problematic behaviors and social functioning resulted in higher scores.

The Home Observation for Measurement of the Environment Inventory (HOME) was assessed at the 30-month visit.<sup>14</sup> The HOME scale measures the social-emotional and cognitive support available within the child's home environment. The inventory items are scored on the basis of family interview and direct observations made by the interviewer. At follow-up visits, mothers or caretakers also gave annual updates of demographic information and ongoing drug use and supplied information on their psychological status, parenting stress, intelligence, abuse potential, household conflict, and self-esteem.

A Brief Symptom Inventory (BSI) questionnaire was administered by interview of the caretaker at the 1-, 12-, and 36-month visits.<sup>15</sup> The BSI is a 53-item questionnaire designed to

reflect the psychological symptom patterns of psychiatric and medical patients as well as community nonpatient respondents. There are 3 global scores, the Global Severity Index, the Positive Symptom Total, and the Distress Index, and there are 9 primary symptom dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The Global Severity Index provides an overall score of primary caregiver psychological symptoms.

### Statistical Analysis

Generalized estimating equations were used to estimate the effects of prenatal methamphetamine exposure, age, and the interaction of exposure and age on behavior problems. The generalized estimating equation procedure extends the generalized linear model to allow for analysis of repeated measurements. Analysis was adjusted for covariates that included maternal alcohol, tobacco, or marijuana use; low SES at birth; postnatal caregiver use of methamphetamine, marijuana, or tobacco; domestic violence and reported child abuse; average primary caregiver psychological symptoms from 1 month to 3 years; quality of the home; and history of any primary caregiver change from birth to age 7.5. After adjusting for these covariates,  $P < .05$  was considered significant. To examine the clinical significance, the frequency of children at or above the clinical cutoff on the CBCL scales was calculated.

### RESULTS

Table 1 shows baseline maternal and neonatal demographic data between the methamphetamine-exposed and nonexposed groups included in the analysis. There were no differences in maternal race, education level, or type of medical insurance, reflective of our matching criteria. Mothers in

**TABLE 2** Comparison of Dyads Included and Not Included

	Included ( <i>n</i> = 339)	Excluded ( <i>n</i> = 73)	<i>P</i>
Maternal and demographic characteristics			
Race, <i>n</i> (%)			.903
White	130 (38.3)	30 (41.1)	
Hispanic	75 (22.1)	17 (23.3)	
Pacific Islander	61 (18.0)	10 (13.7)	
Asian American	47 (13.9)	10 (13.7)	
Black	17 (5.0)	5 (6.8)	
American Indian	9 (2.7)	1 (1.4)	
Marital status, partnered, <i>n</i> (%)	188 (55.5)	39 (53.4)	.751
Maternal education, lower than high school, <i>n</i> (%)	141 (41.7)	31 (43.1)	.834
Maternal age, <i>y</i> , mean (SD)	25.1 (5.7)	25.4 (5.2)	.673
Low SES, <i>n</i> (%)	73 (21.5)	20 (28.2)	.225
Any prenatal care, <i>n</i> (%)	323 (95.3)	68 (93.2)	.453
GA at first prenatal visit, <i>wk</i> , mean (SD)	11.8 (7.5)	12.9 (6.8)	.281
Prenatal methamphetamine, <i>n</i> (%)	171 (50.4)	33 (45.2)	.417
Prenatal tobacco use, <i>n</i> (%)	184 (54.3)	34 (46.6)	.232
Prenatal alcohol use, <i>n</i> (%)	85 (25.1)	21 (28.8)	.513
Prenatal marijuana use, <i>n</i> (%)	61 (18.0)	15 (20.5)	.610
Quality of home (2.5 and 7 <i>y</i> ), HOME average (SD)	40.5 (5.3)	37.3 (3.8)	.108
Primary caregiver psychological symptoms (1 <i>mo</i> , 1 <i>y</i> , and 3 <i>y</i> ), BSI average (SD)	0.47 (0.42)	0.51 (0.51)	.552
Neonatal characteristics			
Sex, boy, <i>n</i> (%)	179 (52.8)	41 (56.2)	.601
Birth weight, <i>g</i> , mean (SD)	3232 (602)	3318 (584)	.264
Low birth weight ( $\leq$ 2500 <i>g</i> ), <i>n</i> (%)	42 (12.4)	5 (6.8)	.177
GA, <i>wk</i> , mean (SD)	38.6 (2.1)	39.0 (1.7)	.158
SGA, <i>n</i> (%)	47 (13.9)	8 (11.0)	.508

SGA, small for gestational age.

the methamphetamine-exposed group compared with the nonexposed group were more likely to have low SES, be without a partner, and use alcohol, marijuana, and tobacco during pregnancy.

Newborns in the methamphetamine-exposed group had a lower GA (Table 1) than newborns in the comparison group. Mothers in the methamphetamine group were more likely to be reported for child abuse, and there was a higher rate of change in caregivers by child age 7.5 years. There was also an increased incidence of postnatal methamphetamine, tobacco, and marijuana use in the methamphetamine-exposed group.

Maternal and newborn characteristics of subjects included in the study versus those excluded are shown in Table 2. There is no difference in baseline characteristics between the included and excluded groups.

Table 3 presents the results of the CBCL assessment at 3, 5, and 7.5 years of age. Analyses adjusted for covariates revealed 5 main effects for age 5 years and 3 main effects for age 7.5 years. Compared with 3 years of age, children at 5 years of age showed fewer externalizing symptoms. Specifically, they had fewer problems with aggressive behavior. In contrast, children at 5 years of age compared with 3 years of age had more internalizing symptoms, including more somatic complaints and more withdrawn behavior. By age 7.5 years, attention problems increased, aggressive behavior continued to decrease significantly, and withdrawn behavior also decreased. There were no main effects for methamphetamine exposure and no interactions of exposure and age.

To examine clinical significance, we measured the frequency of children who scored above the clinical cutoff

on the CBCL at ages 3, 5, and 7.5. At age 7.5 for externalizing behavior, 24.2% of the children in the methamphetamine-exposed group were in the clinical range compared with 13.9% of the children in the comparison group ( $P = .020$ ). At age 7.5 for total problem behavior, 19.6% of the children in the methamphetamine-exposed group were in the clinical range compared with 10.2% of the children in the comparison group ( $P = .023$ ). The rate of clinically significant behavior in the methamphetamine-exposed children is higher than would be expected from the normative sample (ie, 15%).

Caregiver psychological symptoms, as assessed by the BSI, were significant predictors for all behavior problems ( $P = .006$ – $<.001$ ). The quality of the home, as evaluated by the HOME scale, was a significant predictor for externalizing problems and externalizing syndrome scores ( $P = .02$ – $<.001$ ).

## DISCUSSION

This study expands on previously reported work from the longitudinal IDEAL Study. We reviewed changes in the behavioral data across 3 time points: ages 3, 5, and 7.5 years. We found that behavioral changes over time were not significantly associated with methamphetamine exposure. However, caregiver psychological symptoms and the home environment were significant predictors of behavior outcomes assessed longitudinally from ages 3, 5, and 7.5 years.

Our findings that aggressive behavior decreased with age, regardless of methamphetamine exposure, are consistent with previous work in child development. Bongers et al<sup>16</sup> characterized the normative developmental trajectories of behavioral problems in childhood and found there to be a persistent decrease in aggressive behavior and externalizing problems between 4 and 18 years of age. The authors of

**TABLE 3** Externalizing, Internalizing, and Total Problems T Scores by Prenatal Methamphetamine Exposure

CBCL	Age 3 y, Mean ± SE			Age 5 y, Mean ± SE			Age 7.5 y, Mean ± SE			Adjusted Analyses <sup>a</sup>									
	Comparison (n = 147)			Comparison (n = 153)			Comparison (n = 151)			Exposure		Age 5 y <sup>b</sup>		Interaction		Age 7.5 y <sup>b</sup>		Interaction	
	Exposed (n = 141)	Comparison (n = 147)	Comparison (n = 153)	Exposed (n = 153)	Comparison (n = 151)	Comparison (n = 147)	β	P	β	P	β	P	β	P	β	P	β	P	
	54.8 ± 1.1	55.5 ± 0.8	54.7 ± 0.9	56.1 ± 1.0	53.0 ± 0.9	54.8 ± 0.8	-0.68	.65	0.02	.002	2.4	.06	-0.67	.46	1.9	.20			
Externalizing	3.1 ± 0.20	3.4 ± 0.17	3.4 ± 0.21	4.6 ± 0.34	3.5 ± 0.20	4.5 ± 0.28	-0.29	.32	.10	.59	.13	.62	1.1	<.001	.40	.35			
Attention problems	14.1 ± 0.75	13.9 ± 0.59	13.6 ± 0.74	8.8 ± 0.67	12.1 ± 0.67	7.5 ± 0.50	.14	.90	-1.9	.003	1.2	.24	-6.4	<.001	.14	.90			
Aggressive behavior	51.4 ± 0.9	50.9 ± 0.8	55.2 ± 0.8	51.1 ± 0.8	53.2 ± 0.8	50.4 ± 0.8	.50	.70	2.3	.003	1.5	.21	-5.1	.57	.21	.88			
Internalizing	3.0 ± 0.22	2.9 ± 0.19	3.3 ± 0.23	3.4 ± 0.24	3.1 ± 0.24	3.1 ± 0.24	.10	.75	.31	.14	.38	.24	-1.5	.56	.19	.64			
Anxious and/or depressed	1.5 ± 0.15	1.5 ± 0.14	2.0 ± 0.17	1.3 ± 0.14	2.1 ± 0.16	1.4 ± 0.15	-0.03	.89	.54	.001	-1.5	.59	-0.8	.68	-0.03	.89			
Somatic complaints	1.9 ± 0.18	2.0 ± 0.16	2.3 ± 0.19	1.7 ± 0.17	2.5 ± 0.18	1.4 ± 0.14	-1.2	.61	.43	.01	-0.003	.99	-0.67	<.001	.43	.12			
Withdrawn	53.8 ± 1.0	54.7 ± 0.8	55.2 ± 0.9	54.0 ± 0.9	53.8 ± 0.9	54.1 ± 0.8	-0.86	.53	-0.86	.24	2.2	.05	-0.61	.47	8.1	.54			
Total problems																			

<sup>a</sup> Adjusted analyses were used to test the main effects of methamphetamine exposure and child age at assessment (3, 5, and 7.5 y) and the interaction of exposure and age, with adjustment for prenatal exposure to alcohol, tobacco, and marijuana; low SES at birth; postnatal caregiver use of methamphetamine, marijuana, and tobacco; domestic violence, caregiver psychological symptoms; quality of the home; caregiver change; and reported child abuse.

<sup>b</sup> The reference groups were the comparison group for the analysis of exposure and 3 y for the analysis of age.

a longitudinal follow-up study in Sweden of children exposed to prenatal amphetamine reported an overall decrease in aggressive behavior with increasing age: 35% at age 4 years versus 23% at age 8 years.<sup>7</sup> This pattern of behavioral change is similar to what we noted in our study subjects. Previous reports from the IDEAL Study demonstrated that children at 5 years of age compared with children at 3 years of age showed less externalizing and less aggressive behavior. Regarding attention problems, we found that children had a significant increase in attention problems with age, consistent with works of Bongers et al,<sup>16</sup> who noted an increase in attention problems until ~11 years of age.

We found that across these 3 time points of 3, 5, and 7.5 years of age, methamphetamine exposure did not have a direct effect on the behavioral findings. This result is in contrast to previous reports of methamphetamine-exposed children. The authors of a longitudinal study conducted in Sweden of children exposed to prenatal amphetamine reported an increase in aggressive behavior in the exposed children compared with the general population, although they also noted that increased aggression was associated with an increased number of caregivers and maternal psychiatric treatments.<sup>5</sup> This difference may be due to the fact that the methamphetamine-exposed children in the IDEAL Study were matched to comparison subjects with similar baseline demographics, which may account for the effects of other confounding variables. The lack of a significant difference between exposed and comparison children may also be due to the high-risk nature of this sample. Although we did not find a direct effect of methamphetamine exposure, we found that caregiver psychological symptoms had a significant impact on all behavior problems spanning from 3 to 5 to 7.5 years of age and that quality of the

home is a significant predictor of externalizing problems in this study.

These findings are important in that they provide an opportunity for health care providers to identify children who may be at higher risk for developing behavioral problems. Although the mean CBCL scores over time were in the average range for the methamphetamine-exposed and comparison groups, by age 7.5 years, more methamphetamine-exposed children had CBCL externalizing and total problem scores in the clinically significant range, and those scores were a higher rate than would be expected in a normative sample. Environmental factors, such as poor-quality home and maternal psychopathology, play a significant role in a child's development. Previous studies have revealed that unstable homes can influence the development of problematic behavior.<sup>8,17</sup> There are numerous studies linking maternal psychiatric symptoms, such as depression during or after pregnancy, to increased childhood developmental problems in age groups ranging from toddler age to adolescence, including both internalizing and externalizing symptoms.<sup>18-21</sup> The results from the IDEAL Study echo these potential risk factors and provide a target for early intervention. Early identification of children at high risk allows for better screening and support of these at-risk children.

Regarding internalizing symptoms, Bongers et al<sup>16</sup> reported a persistent increase in somatic complaints and withdrawn behaviors between ages 4 and 18 years. Previous reports from the IDEAL Study also demonstrated increased somatic complaints and withdrawn behaviors at 5 years of age compared with 3 years of age. Our results, however, revealed no difference in somatic complaints at 7.5 years of age compared with 3 years of age. There was also less withdrawn behavior at 7.5 years of age compared with 5 years of age.

Limitations to this study include the potential for reporting bias because the CBCL is based on self-reporting by the caregiver. Our results also may not generalize to all children who were exposed prenatally to methamphetamine.

## CONCLUSIONS

Developmental behavior across time from ages 3 to 5 to 7.5 years was not significantly different between

children who were prenatally exposed to methamphetamine and those who were unexposed. In contrast, caregiver psychological symptoms and home environment had a significant influence on behavior outcomes. On the basis of our findings, continued follow-up with these children will help us gain further insights regarding the effects of methamphetamine exposure as they approach adolescence.

## ABBREVIATIONS

BSI: Brief Symptom Inventory  
CBCL: Child Behavior Checklist  
GA: gestational age  
HOME: Home Observation for Measurement of the Environment Inventory  
IDEAL: Infant Development, Environment, and Lifestyle  
SES: socioeconomic status

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