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Journal of Substance Abuse 12 (2000) 329–340

Journal of Substance Abuse

Maternal substance use during pregnancy and developmental outcome at age three

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Abstract

Purpose: The data from the National Maternal and Infant Health Survey (NMIHS) and its 3-year follow-up offer a unique opportunity to study the effects of substance (alcohol, marijuana, and tobacco) use during gestation on development at age three in a nationally representative sample. Using this data, the relationship of development (language, gross motor, fine motor, and adaptive behavior) and specific behaviors (eating problems, length of play, activity level, difficulty of management, level of happiness, fearfulness, ability to get along with peers, tantrums, eating nonfood) and maternal drinking, marijuana use, and cigarette smoking was studied in a sample of live births who had been followed up at age three. **Methods:** The data were analyzed using a cumulative logit model of ordinal responses. **Results:** Higher activity level, greater difficulty of management, tantrums, eating problems, and eating nonfood were related to maternal drinking during pregnancy. Increased fearfulness, poorer motor skills, and shorter length of play were associated with maternal marijuana use during pregnancy. Less well developed language, higher activity level, greater difficulty of management, fearfulness, decreased ability to get along with peers, and increased tantrums were associated with maternal cigarette smoking during pregnancy. The preponderance of significant effects involved the behaviors studied rather than the developmental indices. **Implications:** It may be that the effects of substance use during pregnancy, especially more subtle ones, show up in behavior before they can be measured by developmental scales.

Keywords: Substance use; Pregnancy; Development; Behavior

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0899-3289/01/$ – see front matter
PII: S0899-3289(01)00052-9

1. Introduction

Maternal use of alcohol, tobacco, and/or marijuana during pregnancy has been implicated in the compromised development of children born to mothers who used these substances while pregnant (Coles, Platzman, Smith, James, & Falek, 1992; Day et al., 1991; Fried & Watkinson, 1988, 1990; Jacobson et al., 1994, Streissguth, Clarren, & Jones, 1985; Zuckerman et al., 1989). In general, studies have found that the greater the exposure to substances, the greater the likelihood of a neurodevelopmental or behavioral deficit. However, some studies find no statistically significant neurodevelopmental or behavioral effects of exposure to these substances, particularly at low to moderate levels of consumption and even some heavily exposed children appear to be largely spared (Mattson & Riley, 1998; Weinberg, 1997). Thus, the relationship of prenatal use of these substances and developmental outcome still warrants further investigation.

Many studies have examined the short- and long-term effects on behavioral and developmental outcomes of varying levels of prenatal exposure to alcohol, tobacco, and marijuana. Some of them used longitudinal designs while others studied a group of children at one point in time. Some looked at many measures and several exposures simultaneously while others focussed on a few measures and a single exposure. In general, this rather large group of studies has resulted in mixed findings, with some of them documenting relationships between substance use and poorer development and/or behavioral problems, while others do not. Presented here is a brief description of some recent results limited to children up to about age four.

Studies have shown that moderate prenatal alcohol consumption (as variously defined to range from about one to three drinks/day) was significantly related to disruption in sleep and arousal (Scher, Richardson, Coble, Day, & Stoffer, 1988), lower mental scores at 24 months (Fried & Watkinson, 1988) and at age four and a half (Larroque et al., 1995), and lower verbal and memory scores at ages two and three, but not age four (Fried & Watkinson, 1990). It was also related to increased errors, latency and total time on the Wisconsin Fine Motor Steadiness Battery and poorer balance on a test of gross motor development at age four (Barr, Streissguth, Darby, & Sampson, 1990). On the other hand, Chasnoff, Griffith, Freier, and Murray (1992) found no difference in Bayley Scales of Infant Development (BSID) scores between a group of infants exposed to alcohol and/or marijuana and a group of unexposed infants. Likewise, Feng (1993) found no Bayley score differences between alcohol-exposed infants and control infants and Richardson, Day, and Goldschmidt (1995) found that prenatal alcohol did not predict Bayley scores at 9 or 19 months. Chandler, Richardson, Gallagher, and Day (1996) found no effect of prenatal alcohol exposure on gross motor development at age three.

Prenatal maternal cigarette smoking was shown to be associated with less optimal Brazelton orientation performance (Oyemade et al., 1994), lower mental scores at 12 months, and altered responses on auditory items at 12 and 24 months (Fried & Watkinson, 1988), decreased BSID scores at 19 months (Richardson et al., 1995), almost doubled risk of the infant being a nonbabbler at 8 months (Obel, Henriksen, Hedegaard, Secher, & Ostergaard, 1998), and persistent neurobehavioral effects in the language and motor areas at 1, 2, and 3

years of age (Fried, 1989). By contrast, Richardson et al. (1995) found no relationship between prenatal tobacco exposure and BSID scores at 9 and 19 months.

Maternal marijuana use was found to be related to disruption in sleep and arousal in neonates (Scher et al., 1988), to lower BSID mental scores at 9 months (Richardson et al., 1995), to lower verbal and memory scores at ages three and four (Fried & Watkinson, 1990), and to disturbed nocturnal sleep at age three (Dahl, Scher, Williamson, Robles, & Day, 1995). On the other hand, Fried (1989) found that prenatal exposure to marijuana was not associated with mental, motor or language outcomes at ages one or two and Chandler, Richardson, Gallagher and Day (1996) found no motor effects at age three.

This brief overview of selected relevant studies indicates that maternal use of substances during pregnancy has been implicated in the compromised development of at least some children. Although there are studies in which this relationship was not confirmed, others indicate that the use of various substances during pregnancy may lead to developmental deficits (Mattson & Riley, 1998; Weinberg, 1997). Many factors could account for the disparate findings of the studies cited. These include the use of different measures to assess similar aspects of development, variability due to the small sample sizes used in some studies, and variability in the populations studied with respect to age and socioeconomic status.

The studies cited, as well as the majority of studies in this area, have primarily relied on traditional tests of development such as the BSID and other similarly developed and normed measures, have small to moderate sample sizes ranging from about 130 (Fried & Watkinson, 1990) to 1871 infants (Obel et al., 1998), and have often been conducted on non-US or selective regional populations, for example, populations from specific medical centers (e.g., Day et al., 1991; Streissguth et al., 1985).

The present study is focussed on the relationship of maternal substance use during pregnancy and behavioral and developmental outcomes at age three. It differs from the cited studies in two important respects. First, it analyzes data from a large nationally representative sample of pregnancies. Second, it looks at both a traditional developmental measure (items from the Denver Developmental Scale) as well as specific problem and other behaviors of the child as reported by the mother.

This study uses data from the National and Maternal and Infant Health Survey (NMIHS) and its 3-year follow-up of offspring. Thus, it affords a unique opportunity to examine substance abuse during pregnancy in relation to developmental outcome at age three in a large nationally representative sample of about 8000 mothers and their children. Due to the nature of the data, which is from a large multi-purpose survey, the analyses may not be as specific as those from smaller, more localized, longitudinal studies. Nonetheless, such analyses provide important information about the US population as a whole against which the results of smaller studies of more specific populations can be evaluated. The large size of the sample also allows for more precise estimation of the effects of moderate use of cigarettes, alcohol, and marijuana during pregnancy on child development.

Further, the present study used both a traditional developmental measure and a number of child behaviors as reported by the mother to examine the relationship of drinking, smoking, and marijuana use (cocaine use, although collected, was too rare to be analyzed) during gestation and developmental outcome. Behavior is typically more easily reported by parents

than are more subtle aspects of development. Problem behaviors in particular are often readily noticed and reported by parents, and may provide indications of mild developmental delays before traditional measures are sensitive enough to pick them up. In addition, interpreting the results of traditional tests may be problematic, particularly at young ages, due to problems of reliability and the wide range of developmental trajectories, which are within the normal range. On the other hand, reports of behavior by parents may be more influenced by subjective biases than are more objective measures. The approach in the present study will allow for the evaluation of the consistency and relative utility of these two types of measures at the relatively young age of three.

2. Methods

The data analyzed come from the NMIHS and its 3-year follow-up. This survey was conducted by the National Center for Health Statistics (NCHS) to learn more about high-risk pregnancies and to study factors related to poor pregnancy outcome. The NMIHS actually consists of three samples: a live birth sample, a fetal death sample, and an infant death sample. The live birth sample was analyzed in this study. It consisted of 13,417 live births, which were selected from six race (black, nonblack) by birthweight (<1500, 1500–2499 g and 2500+ g) strata. Since enhanced understanding of poor pregnancy outcome was the goal, low-birthweight infants and black infants were oversampled in the live birth sample.

Some data was collected directly from birth certificates. These included birthweight, baby's sex, the child's characteristics, and limited information about the parents. Other information was collected using a detailed questionnaire mailed to mothers subsequent to delivery of their babies. The mothers' questionnaire included information on delivery of the baby, hospitalizations before and after delivery, previous and subsequent pregnancies, sociodemographic characteristics of the parents, baby's health, prenatal care, and health habits of the mother including use of alcohol, tobacco, marijuana, and cocaine before and during pregnancy. The response rate to the live birth questionnaire was 74% ($n=9953$). When the children were approaching 3 years of age, the mothers were recontacted and asked to complete an additional questionnaire, which included developmental information about their children. Each mother was asked to complete a 16-item scale about her child's skills and to answer questions about problem and other behaviors, both of which are reflective of developmental status. The response rate of live birth mothers at the 3-year follow-up was 83% ($n=8285$) for an overall response rate of 61% (74% times 83%). Additional details about the survey are provided by Sanderson, Placek, and Keppel (1991).

Initially, the data were analyzed using cumulative logit models for ordinal responses (McCullagh & Nelder, 1989) including either alcohol use, marijuana use, or cigarette smoking as an independent variable of exposure and without including any covariates (Tables 1 and 2). The outcome variables included developmental indices based on items from the Denver Developmental Scale and specific problem behaviors. The behaviors were eating problems, length of play, activity level, difficulty of management, level of happiness of the child, fearfulness, ability to get along with peers, tantrums, and eating nonfood (see Table 1

Table 1
Mean substance use by type and level of behavioral problems[a]

Behavioral problem	*n*	Weighted percent	Mean (S.E.) Alcohol (drinks/day)	Cigarettes/day	Marijuana (uses/day)
Eating problem					
No problem	4767	54.90	0.71 (0.09)	2.45 (0.13)	0.08 (0.02)
Occasional problem	2702	37.81	0.56 (0.07)	2.54 (0.16)	0.06 (0.02)
Poor appetite most of the time	632	7.30	0.60 (0.15)	3.14 (0.39)	0.03 (0.01)
Length of play					
>15 min	5799	71.53	0.69 (0.08)	2.61 (0.12)	0.07 (0.01)
5–15 min	2034	25.98	0.47 (0.05)	2.34 (0.18)	0.07 (0.02)
5 min	265	2.48	2.34 (0.39)	2.36 (0.51)	0.02 (0.01)
Activity level					
Very inactive	211	1.96	0.57 (0.25)	**3.44 (0.65)**	0.03 (0.02)
Not very active	51	0.49	1.00 (0.82)	**0.52 (0.23)**	0.03 (0.03)
Moderately active	1706	25.68	0.57 (0.07)	**1.97 (0.18)**	0.07 (0.03)
Very active	5178	63.59	0.63 (0.08)	**2.64 (0.12)**	0.07 (0.02)
Too active	954	8.28	1.04 (0.30)	**3.43 (0.33)**	0.04 (0.01)
Difficult to manage					
Easy	4179	52.17	**0.53 (0.05)**	**2.26 (0.13)**	0.08 (0.02)
Sometimes difficult	3464	43.19	**0.74 (0.12)**	**2.75 (0.15)**	0.05 (0.15)
Difficult most of the time	454	4.65	**1.06 (0.25)**	**3.68 (0.51)**	0.11 (0.07)
Level of happiness					
Usually happy	7085	87.72	0.64 (0.07)	2.47 (0.10)	0.07 (0.01)
Occasionally irritable	891	11.23	0.77 (0.13)	3.00 (0.34)	0.07 (0.04)
Irritable	118	1.06	0.39 (0.21)	3.06 (1.11)	0.10 (0.07)
Fearfulness					
None or mild fears	6516	82.11	0.66 (0.07)	2.52 (0.11)	0.06 (0.01)
A few strong fears	1365	15.97	0.61 (0.09)	2.62 (0.24)	0.11 (0.05)
Many strong fears	216	1.92	0.28 (0.08)	2.71 (0.58)	0.04 (0.02)
Ability to get along with peers					
Gets along well	6798	85.51	0.64 (0.06)	**2.46 (0.10)**	**0.08 (0.01)**
Some difficulty	1135	13.64	0.73 (0.16)	**2.91 (0.25)**	**0.03 (0.01)**
Great difficulty	106	0.85	0.19 (0.10)	**4.45 (1.63)**	**0.00 (0.00)**
Number of tantrums					
Never	1405	15.36	**0.58 (0.09)**	**1.88 (0.20)**	0.07 (0.03)
Occasional	5503	72.54	**0.59 (0.07)**	**2.51 (0.11)**	0.07 (0.02)
Frequent	1185	12.11	**1.08 (0.23)**	**3.57 (0.30)**	0.05 (0.01)

(*Continued on next page*)

Table 1 (*continued*)

Behavioral problem	*n*	Weighted percent	Mean (S.E.) Alcohol (drinks/day)	Cigarettes/day	Marijuana (uses/day)
Eats nonfood					
Never	3547	42.37	0.62 (0.08)	2.76 (0.15)	0.07 (0.02)
Rarely	3706	49.54	0.67 (0.10)	2.29 (0.13)	0.06 (0.02)
Sometimes	668	6.46	0.60 (0.12)	2.85 (0.36)	0.07 (0.03)
Frequently	173	1.62	0.97 (0.37)	3.29 (0.70)	0.33 (0.24)

The significant results are based on significance for either the continuous substance variable or the indicator variable for that substance.

[a] Bold sections indicate where level of substance use varied significantly ($P < .05$) across level of behavioral problem (cumulative logit analysis without covariates).

for the ordinal responses for each problem behavior). The developmental measures of language (seven items), gross motor (four items), fine motor (one item), and adaptive functioning (four items) resulted from the 16-item ''yes, my child can do this–no, my child cannot do this'' Denver scale completed by the mothers. Following this initial phase, the data were further analyzed using cumulative logit models including the following covariates as independent variables: birthweight, child's exact age in months (range was 26.7 to 50.2), child's sex, mother's race, mother's level of education, mother's Hispanic status (Table 3).

For purposes of determining dose–response relationships, numerical values were used to approximate the number of drinks of alcohol per month. No drinking, drinking less than one drink a month, drinking one drink a month, drinking two to three drinks a month, drinking one drink a week, drinking two drinks a week, drinking three to five drinks a week, drinking six to eight drinks a week, drinking 9 to 13 drinks a week, drinking 14 to 20 drinks a week, and drinking more than 21 drinks a week were assigned values of 0, 0.5, 1, 2.5, 4, 8, 16, 28, 44, 68, and 96, respectively. This was computed by taking the midpoint of the range and multiplying by four to convert to the number of drinks per month (for the upper, open-ended interval, 24 drinks per week was used for this computation). Likewise, drug (marijuana) use was assigned numerical values. No drug use, drug use less than once a month, once a month, two to three times a month, one to two times a week, and more than three times a week were assigned values of 0, 0.5, 1, 2.5, 6, and 14, respectively. These assigned values represent monthly drug use and were computed by multiplying the midpoint of the range by four (for the upper, open-ended interval, 3.5 times per week was used for this computation). The number of cigarettes smoked per day was used to measure smoking during pregnancy for all analyses. For the maternal substance use behaviors, an indicator variable (yes/no) was also used in the cumulative logit model. The addition of an indicator variable models the dose effect as a step function, allowing for a discontinuity in the dose–response relationship between individuals who use a substance as compared to those who do not (Faden, Graubard, & Dufour, 1997).

The data in this study come from a survey design with differential sample weights. As such, all analyses weighted the observations by the sample weights using the computer software package SUDAAN to estimate population parameters and their standard errors, and

to compute significance tests and P values (Shah, Barnwell, & Bieler, 1997). All statistical tests were two-tailed and $P < .05$ was used to determine statistical significance.

3. Results

Table 1 presents descriptive information about the sample of children studied. The percentage distribution for each problem behavior is presented by category, and for each category, mean alcohol per day, mean cigarettes per day, and mean marijuana use per day are presented. Univariate analyses of alcohol, cigarette, and marijuana use by problem category

Table 2
Mean substance use by developmental status measures[a]

			Mean (S.E.)		
Developmental status[b]	*n*	Weighted percent	Alcohol (drinks/day)	Cigarettes/day	Marijuana (uses/day)
Fine motor					
0/1	6490	79.26	0.64 (0.05)	2.55 (0.11)	**0.05 (0.01)**
1/1	1580	20.74	0.68 (0.19)	2.53 (0.23)	**0.15 (0.05)**
Gross motor					
0/4	223	1.43	0.39 (0.16)	**1.60 (0.46)**	0.03 (0.02)
1/4	506	5.41	0.90 (0.36)	**2.12 (0.41)**	0.04 (0.02)
2/4	1462	18.13	0.52 (0.08)	**2.09 (0.19)**	0.09 (0.03)
3/4	2863	35.49	0.66 (0.10)	**2.49 (0.16)**	0.07 (0.02)
4/4	2928	39.54	0.68 (0.11)	**2.88 (0.17)**	0.07 (0.02)
Language					
0/7	96	0.59	0.47 (0.37)	**1.38 (0.44)**	0.00 (0.00)
1/7	136	1.41	1.64 (1.28)	**2.67 (0.77)**	0.02 (0.02)
2/7	267	2.80	0.23 (0.10)	**2.46 (0.51)**	0.02 (0.01)
3/7	493	5.51	0.57 (0.17)	**2.82 (0.42)**	0.01 (0.01)
4/7	855	9.91	0.58 (0.12)	**3.00 (0.32)**	0.13 (0.07)
5/7	1323	15.87	0.57 (0.09)	**2.62 (0.24)**	0.07 (0.03)
6/7	1969	24.87	0.74 (0.14)	**2.93 (0.22)**	0.05 (0.02)
7/7	2851	39.04	0.65 (0.10)	**2.12 (0.14)**	0.07 (0.02)
Personal/adaptive					
0/4	97	0.68	1.16 (0.66)	**1.49 (0.59)**	0.00 (0.00)
1/4	327	3.88	0.29 (0.10)	**1.40 (0.33)**	0.01 (0.01)
2/4	828	11.70	0.47 (0.07)	**2.28 (0.25)**	0.08 (0.04)
3/4	2113	27.51	0.69 (0.16)	**2.44 (0.17)**	0.06 (0.02)
4/4	4688	56.23	0.69 (0.07)	**2.71 (0.14)**	0.08 (0.02)

The significant results are based on significance for either the continuous substance variable or the indicator variable for that substance.

[a] Bold sections indicate where level of substance use varied significantly ($P < .05$) across level of behavioral problem (cumulative logit analysis without covariates).

[b] x/y signifies x out of y developmental milestones reached in a given category.

were performed. The distribution of means by problem category is in bold print in the table, for those results, which were statistically significant ($P < .05$). The table indicates that mean cigarette consumption was related to activity level, difficulty of management, ability to get along with peers, and number of tantrums. Mean alcohol consumption was related to difficulty of management and mean and number of tantrums marijuana use varied significantly across ability to get along with peers.

Table 2 presents similar information for developmental status as reflected by fine and gross motor development, language development, and adaptive behavior. Again, the distribution of means by developmental level is in bold type in the table, for those results, which were significant ($P < .05$). An examination of this table indicates that there are few significant results. In fact, the results appear to indicate that higher levels of smoking are related to more favorable gross motor and adaptive development, but this may have occurred because the results reported in this table are not adjusted for important confounders. On the other hand, these confounders are taken into account in the logit analysis, as described below.

The statistically significant ($P \leq .05$) and borderline results ($.05 < P \leq .10$) of the logit analyses and their associated odds ratios and P values are presented in Table 3. This table indicates a number of significant relationships between substance use and developmental status at age three in this sample. Greater difficulty of management and eating nonfood were found to be related to drinking during pregnancy. They were related to the continuous drinking variable and the second to the indicator variable for drinking. Increased fearfulness and poorer gross motor development were associated with marijuana use. The first was related to the continuous marijuana variable. Less well developed language, higher activity level, greater difficulty of management, decreased ability to get along with peers, and increased tantrums were associated with cigarette smoking during pregnancy. Language was related to the continuous smoking variable and the other problems were related to the indicator variable for smoking. A number of borderline significant results in the expected direction were also noted: higher activity level, tantrums, and eating problems were found to be related to drinking during pregnancy; shorter length of play was associated with marijuana use; and fearfulness was associated with cigarette smoking during pregnancy.

4. Discussion

As more and more children are being diagnosed with learning, attention, and behavioral problems, we are seeking to better understand the etiology and presentation of their difficulties. The results of the present study may be helpful in this regard. In this study, a number of behavior problems were associated with prenatal exposure to alcohol, marijuana, and tobacco. In fact, the preponderance of significant results in this study involved the problem behaviors, not the developmental indices. A notable exception was the index for language development, which was found to be related to smoking, consistent with prior studies (Fried & Watkinson, 1988, 1990; Obel et al., 1998). Thus in the present sample, it was seen that at young ages, behavioral problems were more apparent than slowed development in exposed as compared to unexposed or lesser-exposed offspring. This is consistent with

clinical observations in which children often present with behavioral difficulties (for example, because their parents find them difficult to manage, or because they are disruptive in preschool programs) before measurable developmental delays or learning problems are picked up. At young ages in particular, developmental delays, especially more subtle ones, may be masked by the wide range of developmental trajectories which are considered to be within the normal range. In addition, parents (mothers, in the present study) of young children are typically more aware of behavioral difficulties than developmental lags unless the failure to achieve a milestone is very dramatic, for example, failing to walk or to speak. As such, behavioral measures may offer an advantage over standardized tests which are often difficult to administer to young children, who may have short attention spans, become tired during testing, or fail to perform optimally for other reasons, decreasing the reliability of such tests for young children. Furthermore, such tests may not be sufficiently sensitive to reliably pick up subtle deficits in young children.

Also important to consider is the relationship between the physical and neuropsychological development of children and its association to maternal substance use. The relationship of maternal substance use and physical developmental of offspring, as seen in general growth retardation, smaller head size, and lower birthweight (Coles et al., 1992; Day et al., 1991; Mills, Graubard, Harley, Rhoads, & Berendes, 1984; Streissguth et al., 1985) is more readily specified than the relationship between prenatal substance use and neurological or neuropsychological development (Fried, 1991; Fried & Watkinson, 1990; Mattson & Riley, 1998; Richardson et al., 1995; Streissguth, Barr, & Sampson, 1990), but the latter link is becoming clearer as research accumulates. Other studies (Fisch, Bilek, Horrobin, & Chang, 1976; Ounsted, Moar, & Scott, 1984; Tanner, 1969; Willerman, 1972) have documented the relationship between physical and neurological development. For example, small head circumference has been shown to result from certain kinds and amounts of substance use and smaller head size has been associated with compromised cognitive development (e.g., lower IQ) and poorer developmental outcomes (Fisch et al., 1976; Ounsted et al., 1984).

The present study, like many others involving young children, relied on mothers' reports about their children. Although mothers' reports of child behavior may be biased, this is the only practical way to collect this information in a national study of this size. Unfortunately, it is impossible to assess the extent or source of this type of bias in the present data. Some mothers might feel guilty about their substance use and therefore underreport difficulties with their children. Other mothers may be biased toward accomplishment on developmental scales, but report actual behavior more accurately. Other possibilities are also plausible. Despite the issue of bias in parental report, such reports have been widely used to evaluate development among young children and there are many well-known scales, which rely on mother's report for information (for example, the Achenbach Child Behavior Checklist and the parent portion of the Conners' Rating Scales).

There is also the possibility of bias in self-report of the use of alcohol, cigarettes, and marijuana, as was done in this survey. Typically, these are underreported. This type of bias can pose a substantial analytic problem, since underreporting of substance use makes it harder to identify significant associations between the exposure and the children's developmental and behavioral outcomes.

Several additional cautions are important to note when interpreting the results of the present study. As in all observational follow-up studies, there may be important covariates left out (such as prenatal care, nutrition, or socioeconomic indicators) or incorrectly modeled in the regression analyses, which could lead to biased estimates of the effects from exposure to alcohol, tobacco, or marijuana. Perhaps most important among these covariates is explanatory information about what occurred between the child's birth and the time of follow-up. For example, mothers who drank during pregnancy may parent less effectively, and this may result in spurious associations. Furthermore, although age was included in the regression analyses, there still might be effects of age on behavior that may not be fully adjusted for.

How to best intervene with exposed children to maximize development remains an important question. For example, it may be that better parenting or enrolling at risk children in enrichment programs may mitigate the negative effects of exposure to substances in this population of children. If so, these or other early interventions may have a large pay-off in eliminating or diminishing the negative outcomes associated with prenatal exposure to alcohol, tobacco, and marijuana.

The results of the present study are potentially important because problem behaviors may serve as markers for compromised development before developmental deficits, especially subtle ones, can be measured by standardized tests. Since parents typically can more easily report problem behaviors than nuances in neurodevelopmental progress, the existence of problem behaviors may alert health practitioners and educators to the possibility of developmental problems caused by substance use during pregnancy before standardized scales pick them up. This may allow for earlier intervention with these children than would be possible if one waited for deficits to show up on specific developmental tests. Furthermore, results from large national studies are potentially more influential in prevention messages than results from studies that rely on regionally based or convenience samples. As such, the results from this study may have an important role to play in educating pregnant women or women planning to become pregnant.

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