Neurotoxicology and Teratology 31 (2009) 325–333

Contents lists available at ScienceDirect

Neurotoxicology and Teratology

journal homepage: www.elsevier.com/locate/neutera

Continued effects of prenatal cocaine use: Preschool development ☆

Gale A. Richardson [a,*], Lidush Goldschmidt [b], Jennifer Willford [a]

[a] University of Pittsburgh School of Medicine, Western Psychiatric Institute and Clinic, 3811 O'Hara Street, Pittsburgh, PA 15213, United States
[b] University of Pittsburgh Medical Center, Western Psychiatric Institute and Clinic, 3811 O'Hara Street, Pittsburgh, PA 15213, United States

ARTICLE INFO

Article history:
Received 17 February 2009
Received in revised form 7 August 2009
Accepted 8 August 2009
Available online 18 August 2009

Keywords:
Prenatal cocaine exposure
Preschool age
Growth
Cognitive development
Temperament
Behavior problems

ABSTRACT

The relationship between prenatal cocaine use and preschooler's physical and cognitive development and behavioral characteristics was examined, controlling for other influences on child development. On average, children were 38.5 months old, women were 29.4 years old, had 12.3 years of education, and 47% were African American. During the first trimester, 18% of the women were frequent cocaine users (≥1 line/day). First trimester cocaine exposure predicted decreased head circumference at 3 years and lower scores on the short-term memory subscale of the Stanford–Binet Intelligence Scale (SBIS) [74]. There was no significant relationship between prenatal cocaine use and the other SBIS scales. First trimester cocaine use also predicted more total, internalizing, and externalizing behavior problems on the Child Behavior Checklist [3] and higher scores on the fussy/difficult scale of the Infant Characteristics Questionnaire [6]. Children who were exposed to cocaine throughout pregnancy had more behavior problems and were more fussy compared to children of women who never used cocaine prenatally. A repeated measures analysis showed that children of first trimester cocaine users became more fussy over time. These detrimental effects on growth and behavior are consistent with other reports in the literature and with the hypothesis that prenatal cocaine exposure affects development through changes in neurotransmitter systems.

1. Introduction

The effects of prenatal cocaine exposure (PCE) on child development are an important public health issue, with rates of prenatal cocaine use ranging from 1% in the National Pregnancy and Health Survey [52] to 2.6% in a partially rural sample from Florida [31] to 8% in our longitudinal study of prenatal cocaine exposure (PCE) [58] to 18% in an inner-city sample from Boston [80]. It is important to determine whether the associations between PCE and neonatal and infant development that have been reported persist into the preschool period (3–5 years), or whether new relations will emerge. The outcomes that are typically investigated are growth, cognitive development, and behavior.

Griffith, Azuma, and Chasnoff [35] found that the 3-year head circumference was smaller in two drug-exposed groups compared with a non-drug-exposed group, although the two drug groups did not differ from each other. In a report from an adoption counseling service, PCE was associated with reduced head circumference and height at approximately 4–5 years [54]. By contrast, other researchers have reported that PCE was not associated with preschool growth [13,40,44,46].

There have been reports of relationships between PCE and specific areas of cognitive functioning in 3–4-year-olds, including short-term memory [11], verbal reasoning [11,35], abstract–visual reasoning [12], performance IQ [53], and visual–spatial and arithmetic scores [72]. In general, PCE has not been found to be associated with deficits in global preschool cognitive development, as measured by scales such as the Bayley Scales of Infant Development (BSID-II) [7], the Stanford–Binet Intelligence Scale (SBIS) [74], the Wechsler Preschool and Primary Scale of Intelligence-Revised [77], and the McCarthy Scales of Children's Abilities [48] [2,5,8,32,37,40,49,51,53,72], although Lewis et al. [44] reported a relationship between PCE and lower mental and psychomotor scores on the BSID-II and Bennett et al. [12] reported that PCE predicted lower composite SBIS scores for exposed boys only.

The literature is also inconsistent in the behavior domain. PCE has been reported to be associated with increased caregiver-reported behavior problems in preschoolers, particularly externalizing behavior [4,35], with aggression [10], with shorter latency to frustration and increased disruptive behaviors in exposed boys [29], and with poorer attention on laboratory vigilance measures [2,5,9]. By contrast, no significant relations were found between PCE and caregiver's ratings of preschooler's behavior problems [1,11,76], nor with trained observer's ratings on the BSID-II Behavior Rating Scale [49].

The inconsistencies in this literature could be due to a number of methodological factors, including failure to control for differences between exposure groups, different sample characteristics, especially in terms of patterns of drug use, differential rates of attrition between exposure groups, and high rates of subject loss across time [58,61].

☆ This research was supported by the National Institute on Drug Abuse grants DA05460 and DA06839 (G. Richardson, Principal Investigator).

* Corresponding author. Tel.: +1 412 681 3482; fax: +1 412 246 6875.
E-mail address: gar@pitt.edu (G.A. Richardson).

0892-0362/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.ntt.2009.08.004

The research presented here is a longitudinal study of prenatal cocaine use that was designed to address these factors. We can also address the timing of PCE because multiple interviews were conducted to obtain trimester-specific substance use data. This report evaluates the relations between PCE and preschool physical, cognitive, and behavioral development. Based on our findings at the 1-year follow-up [63] and on those in the literature, we hypothesized that the strongest association would be with PCE and behavior problems, and that this relation would remain significant after adjusting for covariates of cocaine use. We further hypothesized that cocaine use during the first trimester would have an impact on the outcomes, as would continued use throughout the pregnancy.

2. Methods

2.1. Study design

The sample consisted of women and children participating in a longitudinal investigation of the effects of PCE. Written consent was obtained according to guidelines established by the University of Pittsburgh's Institutional Review Board and by the Research Review and Human Experimentation Committee of Magee-Womens Hospital. A Confidentiality Certificate, obtained from the Department of Health and Human Services, assured participants that their responses could not be subpoenaed.

Women who were at least 18 years of age were initially interviewed when they came for prenatal care during their fourth or fifth prenatal month. Women in this prenatal care sample were not enrolled if they did not initiate prenatal care by the fifth month of pregnancy. During the initial interview, information was obtained about cocaine, crack, alcohol, tobacco, marijuana, and other illicit drug use in the year prior to pregnancy and during the first trimester. All women who reported any cocaine or crack use during the first trimester were enrolled. The next woman interviewed who reported no cocaine or crack use during both the year prior to pregnancy and the first trimester was also enrolled. The selected sample was interviewed at 7 months and at 24 h post-delivery about substance use during their second and third trimesters, respectively. Techniques used to enhance the accuracy of reporting can be found in previous publications [25,63]. All infants were examined at delivery by study nurses who were unaware of prenatal exposure status. At 1 year postpartum, growth, mental and motor development, and temperament were assessed [63].

At the 3-year phase, the child's growth was measured and his/her medical history was obtained from the mother. Cognitive development was assessed with the Stanford–Binet Intelligence Scale-4th Edition (SBIS) [74], which consists of the following scales: verbal reasoning (VR), reflecting verbal comprehension and reasoning; abstract/visual reasoning (AVR), reflecting visual–perceptual analysis; quantitative reasoning (QR), reflecting early math concepts; short-term memory (STM), including visual and auditory short-term recall; and the composite score [28]. These scores are normed to have an average of 100 and standard deviation of 16. After the assessment, examiners completed the SBIS global ratings, which reflect the examiner's perception of the child's responsiveness and activity during the test. The examiners were bachelor's or master's level research staff who had extensive experience administering standardized child assessments. They were trained to reliability and supervised by a developmental psychologist (GAR). Examiners were blind to prenatal and current substance use status. Periodic reliability checks were conducted to maintain consistent administration and scoring.

At 3 years, the mothers were interviewed about substance use during the last year and their demographic and psychological characteristics, household composition, and social support (how often have contact with friends and relatives; someone to turn to in times of need; support received in role as a mother; satisfaction with help received). Maternal depression was assessed using the Center for Epidemiological Studies-Depression Scale (CES-D) [56] and anxiety and hostility were measured by the Spielberger State-Trait Anxiety Inventory (STAI) [73]. The Home Screening Questionnaire (HSQ) [20] was used to measure aspects of the home environment that correlate with cognitive development.

The mother's view of the child's temperament was measured using the Infant Characteristics Questionnaire (ICQ) [6]. This scale, also used at the 1-year phase, describes four dimensions of temperament: fussy/difficult (ease of becoming upset), unadaptable (how child responds to new situations), persistent (how child reacts to discipline), and unsociable (interest in people). Cronbach's alphas for the current sample were 0.70, 0.71, 0.74, and 0.28 for the four dimensions, respectively. The unsociable scale was eliminated from the analyses because of the low alpha. The Child Behavior Checklist/2–3 (CBCL) [3] was also completed by the caregivers at 3 years. The mean *T* total behavior problems score for the non-referred sample described by Achenbach [3] is 50 and for the clinically-referred sample is 63.8 [3].

2.2. Sample characteristics

Women were recruited for the study between March 1988 and December 1992. Ninety percent of those approached agreed to participate. Medical chart reviews of a random sample of women who refused to participate indicated that only 5% had a history of drug use during the current pregnancy. A total of 320 women met the inclusion criteria and were enrolled into the study. Between enrollment at the 4th or 5th month of pregnancy and delivery, 20 subjects were eliminated for the following reasons: home delivery, miscarriage/abortion/fetal death, moved, lost to follow-up, and refused. Women could miss the 7-month interview, but not the delivery interview, and still remain in the study. Thus, delivery assessments were completed on 300 women. Four pairs of twins and one child with Trisomy 21 were excluded from additional follow-up, resulting in a birth cohort of 295 mothers and infants.

By 3 years, 32 subjects were lost to follow-up: 4 children died, 2 mothers lost custody and the children could not be traced, 13 families moved out of state, 8 mothers refused to participate, and 5 were missed. The 263 subjects interviewed at the 3-year follow-up represented 89% of the birth cohort. Seven percent of the children were not in maternal custody at 3 years, in which case the current caretaker was interviewed. The majority of these caregivers were relatives of the child (father, grandparent, aunt).

Three children with severe disabilities (autism, Alagille Syndrome, Tourette's Syndrome) and 2 children whose SBIS testing conditions were rated as seriously detrimental due to maternal interference in the testing were excluded from the analyses, resulting in an analysis cohort of 258 mothers and children. The mothers who were not included in the 3-year analysis ($N = 37$) were shorter (63.6 vs. 64.5 in., $p < .05$) and had higher CES-D scores at delivery (46.4 vs. 41.4, $p < .05$) than those who were included in the analysis ($N = 258$). There were no other significant differences in maternal sociodemographic, prenatal substance use, or infant birth characteristics between those who were and were not included in this analysis.

The median child age at assessment was 37 months (mean = 38.5 months; SD = 4.3; range = 33–59). Ninety percent were seen by 44 months of age. Fifty-two percent of the children were male. The average weight was 33.7 lb (range = 23–71), height was 38.3 in. (range = 34–44), and head circumference was 500 mm (range = 457–559). The mean SBIS scores were: VR-94; AVR-90; QR-94; STM-101; and composite-93 (range = 67–118). At 3 years, 25% of the children had attended preschool or child care.

At the 3-year follow-up, the women were, on average, 29.4 years old (range = 21–67), 53% were Caucasian, and 47% were African American. Women had a median family income of $700/month