Three-Year Developmental Outcomes in Children with Prenatal Alcohol and Drug Exposure

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Purpose: The purpose of this study was to describe the performance of children whose mothers abused alcohol and drugs heavily during pregnancy, using the Bayley Scales of Infant Development Second Edition (BSID-II) at three years, and to examine the effects of study group, prenatal binge alcohol exposure, and prematurity on developmental outcome. **Methods:** Children were born to mothers recruited from two large hospitals or through community referral. Hospital recruits were randomly assigned to either a three-year paraprofessional home visitation intervention program (n = 30) or a control group (n = 31). Community recruits were enrolled in the intervention program (n = 35). **Results:** Among all children the mean BSID-II Mental Developmental Index (MDI) was 84.4 (SD = 14.4) and mean Psychomotor Developmental Index (PDI) was 84.1 (SD = 16.9). Box plots of the MDI and PDI scores by study group, maternal prenatal binge alcohol status, and a binary indicator of prematurity suggested an effect of maternal binge drinking on MDI and PDI scores: children of mothers with a history of binge alcohol consumption have, on average, slightly lower scores. We saw no evidence of a systematic effect of the maternal intervention. **Conclusions:** Developmental performance of preschool children exposed to alcohol and drugs prenatally was, on average, substantially lower than expected for age regardless of study group. Although this home visitation intervention has been shown to be effective in helping mothers address a wide spectrum of needs, it is unlikely sufficient to overcome complex developmental risks of children exposed to alcohol and drugs prenatally. The effect of more comprehensive, multidimensional services specifically designed for the children should be investigated within this context. **(Pediatr Phys Ther 2002;14:145–153)** *Key words: prenatal exposure/delayed effects, infant, psychomotor performance, alcohol-related disorders, substance-related disorders, child development, cocaine/adverse effects, alcohol/adverse effects*

INTRODUCTION

Prenatal intrauterine exposure to alcohol and illicit drugs continues to be a significant and complex public health concern. In recent years there have been increasing

efforts to promote prevention of prenatal alcohol and drug exposure and to conduct research examining the effects of exposure on development. Even with these efforts, however, prenatal alcohol exposure seems to be on the increase.[1] With an estimated 5.5% of pregnant women using illicit drugs, prenatal drug exposure shows no indication of decline.[2] Pediatric physical therapists, often the first to provide comprehensive developmental assessment of infants and young children, will increasingly provide services to children who have experienced prenatal alcohol and drug exposure.

The causal relationship between prenatal alcohol exposure and adverse developmental outcome has been clearly established.[3] Primary disabilities have been reported across the lifespan in individuals with fetal alcohol syndrome and in individuals classified as having fetal alcohol effects. In contrast, the longitudinal investigation of the effects of prenatal exposure to other drugs is more limited.

Studies examining the effects of prenatal drug exposure on neonates and infants suggest that given their neurobehavioral characteristics, concern with regard to later development is warranted.[4–6] Research examining developmental outcome later in infancy through early school age has yielded variable results. Several researchers have reported no or few developmental differences between children who experienced prenatal exposure to drugs and control groups.[7–11] Others have reported transient differences on developmental and cognitive measures,[11–13] whereas others have described drug effects on behavioral characteristics in the absence of cognitive impairment.[10,13,14]

It is difficult to interpret the collective findings of these studies because of differences in research design and limitations of the studies. Varying methods of drug classification, small sample size, lack of or inappropriate comparison groups, and limitations in the control of confounding factors constrain the interpretation of findings.[11] Furthermore, although much of the literature on the effects of prenatal drug exposure highlights the effects of a single substance, in many of these studies polydrug exposure is more likely. The effects of poverty, poor maternal and infant health care and nutrition, lack of social support, and ongoing issues related to substance dependency further confound the study of developmental outcome and contribute to the complexity of the problem.[11,13,15,16] Given the limitations in the longitudinal data currently available, the developmental prognosis for children who experience prenatal drug exposure is not definitively known.

In recent years in the United States, there has been an increase in home visitation programs to promote healthy families. Many of these preventive programs target pregnant women or new mothers and their children who are at risk for adverse social, health, and developmental outcomes. Although the stated purposes, specific goals, and methods of the programs vary, they typically share an overarching mission to improve parental competence and enhance child health and development.[17] A recent study of six nationally established home visitation models yielded mixed results regarding the efficacy of home visitation. Even when maternal and child outcomes were positive, effects were small.[17–22] Positive maternal outcomes and developmental advantages for children whose mothers participated in home visitation were inconsistent across sites[19,21] and among subsets of participants.[15,20]

Modest improvements have been reported in the responsible behavior of women who have abused drugs and who have received home visitation, including decreased drug use, better compliance with their children's primary care appointments, and a more responsive and stimulating home environment for their children.[23] The use of trained lay home visitors to intervene during the first year of life with infants at high risk from low-income families, whose problems sometimes included substance abuse, has been reported to have positive effects on the child-rearing environment.[24]

Recently a three-year prospective longitudinal study demonstrated the positive effects of a federally funded paraprofessional home visitation intervention, the Seattle Birth to 3 Program, on outcomes among mothers who abused alcohol and drugs heavily during pregnancy and their children. The primary aims of the intervention, now known as the Parent-Child Assistance Program (P-CAP), were to assist mothers in obtaining alcohol/drug treatment and staying in recovery and to help families resolve the complex problems that arise within the context of maternal substance abuse.[25–27]

Purpose

The purpose of the present study was to describe the performance of children whose mothers were enrolled in the Seattle Birth to 3 Program, using the Bayley Scales of Infant Development Second Edition (BSID-II)[28] at three years, and to examine the effects of study group, prenatal binge alcohol exposure, and prematurity on developmental outcome.

METHODS

Participants

The sample was recruited from July 1991 through December 1992 from two large Seattle area hospitals on the first day postpartum and through community referral within one month of delivery. Children participating in this study were born to mothers enrolled in the Seattle Birth to 3 Program. Mothers were eligible to participate in the program provided they met the following inclusion criteria: singleton birth, self-report of heavy drug and/or alcohol abuse during pregnancy (see Table 1 footnote for details), recruited within one month of delivery, and not successfully engaged with community agencies or service providers, and minimal or no prenatal care.

Human subjects approvals were obtained from the University of Washington and participating hospitals, and informed consent was obtained from all participants. A Certificate of Confidentiality was obtained from the federal government to further protect the privacy of participants.

Recruitment and Group Assignment

Hospital recruitment. A program research assistant asked women who were postpartum and who delivered at one of two urban hospitals to complete a confidential one-page screening questionnaire eliciting demographic information and information about alcohol and drug use during pregnancy and in the month before they became pregnant. After completing the screening questionnaire, mothers who met eligibility criteria were invited to participate in the project and told that they would either be enrolled as control subjects (receiving the community standard of care) or as clients (receiving three years of home visitation with an advocate). All participants were told that in three years they would be interviewed and their infants would be evaluated. Those who agreed were asked to sign informed consent and were assigned at random to either the hospital-recruited client group (HRC, n = 35) or the control group

TABLE 1.

Enrollment demographic and substance abuse* characteristics among mothers of children in the hospital-recruited, community-recruited, and control groups evaluated at three years

	Clients			Control Subjects
	Recruited from Hospital (n = 23)	Recruited from Community (n = 30)	Total Clients (n = 53)	Recruited from Hospital (n = 25)
Age (y), mean (SD)	28.1 (6.1)	27.2 (5.4)	27.6 (5.7)	28 (5.7)
Education (y), mean (SD)	11.6 (1.6)	11.3 (1.6)	11.4 (1.6)	11.5 (1.1)
Race, %				
African American	34.8	63.3	50.9	25.0
White	30.4	23.3	26.4	50.0
Native American	21.7	10.0	15.1	20.8
Other (Hispanic, Asian)	13.0	3.3	7.6	4.2
Parity,† mean (SD)	3.2 (1.8)	3.3 (1.4)	3.2 (1.6)	2.8 (1.4)
Inadequate prenatal care,‡ %	75.0	84.0	80.0	72.0
Substance abuse during pregnancy, %				
Alcohol	78.3	76.7	77.4	76.0
Binge alcohol (≥5 drinks per occasion)	30.4	53.3	43.4	40.0
Marijuana	43.5	46.7	45.3	56.0
Cocaine	91.3	90.0	90.6	84.0
Heroin	30.4	16.7	22.6	32.0
Other street drugs	0.0	3.3	1.3	8.0

* Criteria for enrollment included heavy drug or alcohol use, defined as any of the following: 1) any amount of cocaine or heroin once a week or more; 2) three or more drinks of alcohol daily; 3) any use of five or more drinks per occasion (binge alcohol pattern); or 4) self-report of more moderate use, but a positive maternal and/or infant urine toxicology screen at delivery.

† Total includes child.

‡ Utilization Index.[29]

(n = 31). The research assistant administered a more detailed postpartum interview to participants before discharge.

Community referral. Referrals of women who were high risk and classified as substance abusing and their babies were accepted into the Birth to 3 Program from local health, social, and welfare providers if they met enrollment criteria. Clients referred from the community (CRC, n = 30) were contacted by the program director, completed the intake-screening questionnaire, and were asked to participate if eligible. They were interviewed within one week after delivery or postpartum enrollment. Because their enrollment in the program was considered to be a service in response to a community need, women referred from the community were not assigned to the control group but received the same advocacy services as clients recruited in the hospital. In all, 65 mother/baby pairs were assigned to the advocacy intervention group, and 31 mother/baby pairs were assigned to the control group.

Home Visitation Advocacy Intervention

The home visitation advocacy intervention was based on relational theory, which recognizes that women will be at different stages of readiness for change and emphasizes the importance of interpersonal relationships in women's addictions, treatment, and recovery.[25] Central to the intervention was individualized programming, permitting each mother to work toward goals that were realistic and appropriate for her. Clients were not required to obtain alcohol/drug treatment, nor were they asked to leave the program because of relapses or setbacks (eg, incarceration) or having their children removed from the home.

The paraprofessional advocates had personal experience with many of the same types of adverse life circumstances as their clients and functioned as positive role models with a realistic perspective. Advocates worked with a caseload of 12 to 15 clients and their families from the birth of the child participating in this study until the child was three years old. They made weekly home visits for the first six weeks, followed by twice monthly or more frequent contact depending on client needs. The advocates linked clients with appropriate service providers and transported them and their children to important appointments. During the three-year intervention period advocates worked actively within the context of the clients' extended families. If the child did not remain in the mother's custody, advocates made every attempt to work with the child's caregiver.[25,26]

The Seattle Birth to 3 Program did not include a developmental intervention component for the enrolled infants or specific parenting training for the mothers. Advocates, however, linked clients with health care, parenting classes, and therapeutic childcare as available in the mothers' communities and substance abuse treatment programs. In addition, pediatric physical therapists conducted developmental assessments of the children in the client group at four months and two and three years of age (corrected for prematurity). At all developmental assessments, the pediatric physical therapists discussed the infants' progress with the mothers and provided developmentally appropriate recommendations. The mothers in the control group

had access to community social and health services but did not receive home visitation and advocacy intervention, and their children were evaluated only at three years.

Data Collection

The primary investigator, a pediatric physical therapist with extensive experience in infant assessment, collected developmental data on the children. At three years corrected age, all children were evaluated using the Mental, Motor, and Behavior Rating Scales of the BSID-II.[28] Growth parameters (height, weight, and head circumference) were also recorded.

Instrumentation

BSID-II. The BSID-II is an individually administered, norm-referenced evaluation instrument designed to assess the current developmental functioning of infants and children from one to 42 months of age. The Mental Scale includes items that address memory, habituation, problem solving, early number concepts, generalization, classification, vocalizations, language, and social skills. The Motor Scale is designed to assess gross motor skills, including the ability to roll, crawl, creep, sit, stand, walk, run, and jump, and fine motor skills, including adaptive grasp, use of crayons and pencils, and imitation of postures. Scores on the Mental and Motor Scales of the BSID-II are expressed as standard scores and consist of the Mental Developmental Index (MDI) and the Psychomotor Developmental Index (PDI), each with a mean of 100 and a standard deviation of 15. Entering the raw scores in the age-appropriate conversion table derives indices for the Mental and Motor Scales. In this study, the child's age corrected for prematurity was used to select the appropriate conversion table.

The Behavior Rating Scale (BRS) of the BSID-II provides a qualitative assessment of the child's behavior during the administration of the Mental and Motor Scales and includes task reactivity, task persistence, distractibility, activity level, quality of motor performance, affect, and social orientation. Initial studies examining the validity of the BRS suggest it measures a dimension that is related to but different from the Mental and Motor Scales and that it has utility in differentiating children with significant impairments from children who are developing typically.[28]

Reliability coefficients calculated using coefficient α suggest that the BSID-II is highly reliable. At 36 months the reliability of the Mental Scale was $r = 0.89$; of the Motor Scale, $r = 0.81$; and of the BRS total score, $r = 0.89$.[28]

Data Analysis

Maternal demographic and substance abuse characteristics at enrollment, the child's gestational age, and growth parameters at age three were summarized using descriptive statistics. Group differences for categorical variables were evaluated by means of chi-square tests, and continuous data were evaluated by an analysis of variance. We examined MDI, PDI, and BRS total and factor scores among the three groups. BRS classification as within normal limits (WNL), questionable, or nonoptimal was based

on the criteria defined in the BSID-II manual.[28] Statistical modeling was done to examine the effects of various factors on BSID-II scores. MDI and PDI scaled scores both truncated low scores to 49 by convention. We discuss later the influence of three cases so truncated on regression analyses. Our primary observations were based on regression models including three predictive terms: a factor for the study design group (HRC, CRC, and control); an indicator of maternal report of prenatal binge alcohol use; and a piecewise linear effect for gestational age, linear up to 38 weeks with a plateau for infants born at term (>37 weeks). We conducted analyses with and without study group by alcohol interaction effects. We also carried out the basic analyses substituting indicators of marijuana, heroine, and crack use for the binge alcohol indicator. These analyses were carried out individually because the small sample size precludes efforts to discern the effects of combinations of prenatal exposures. All tests of significance were based on an α level of 0.05.

RESULTS

Participant Characteristics

Eighty-one children were available for the three-year evaluation. Twenty-three (82%) of the 28 children in the HRC group, 30 (88%) of the 34 children in the CRC group, and 25 (81%) of the 31 children in the control group who were located were evaluated. There were no significant differences among the three study groups on maternal enrollment, demographic characteristics, or substance abuse characteristics (Table 1). Among the three groups, mean maternal age was approximately 28 years, mean education was between 11 and 12 years, and mean parity was approximately three. Most of the mothers in each group had inadequate prenatal care.[29] Cocaine and alcohol were the substances most frequently reported as used prenatally among all three groups.

A total of 27 (35.5%) children were born preterm (≤37 weeks' gestation). Gestational age at delivery was not significantly different among children in the three study groups. Fifty-two percent (n = 12) in the HRC group were born preterm, compared with 24% (n = six) in the control group and 32% (n = nine) in the CRC group (two children in the CRC group did not have valid gestational age assessments) ($p = 0.112$). No significant differences in height, weight, or head circumference at age three years were found among children in the HRC, CRC, and control groups (Table 2).

BSID-II Outcomes

Mean BSID-II scores were not significantly different across the three study groups. In the pooled sample (n = 78), approximately half of the children scored one standard deviation below the normative mean on both the Mental and Motor Scales. Approximately 20% scored at or below two standard deviations below the mean on both scales (Table 3).

TABLE 2.

Growth parameters of children in the hospital-recruited, community-recruited, and control groups evaluated at three years*

| | Clients | | | Control Subjects |
	Recruited from Hospital (n = 23)	Recruited from Community (n = 30)	Total Clients (n = 53)	Recruited from Hospital (n = 25)
Height (cm)	93.1 (4.4)	93.2 (9.8)	93.1 (7.9)	94.4 (4.7)
Weight (kg)	11.6 (1.7)	14.6 (2.1)	14.6 (1.9)	14.7 (2.6)
Head circumference (cm)	49.5 (1.9)	50.7 (8.2)	50.1 (6.3)	49.3 (1.6)

* Values are mean (SD).

Total scores on the BRS indicate that among all children, 55% were characterized as WNL, 22% as questionable, and 23% as nonoptimal. In comparison, in the standardization sample of the BSID-II, 75% of children were characterized as WNL, 25% as questionable, and 10% as nonoptimal.[28] On the individual BRS factor scores, 63% of the children in the study were classified as either questionable or nonoptimal on motor quality, 37% were questionable or nonoptimal on orientation/engagement, and 26% were questionable or nonoptimal on emotional regulation.

Regression models including the three predictive terms, a factor for the study design group, an indicator of maternal prenatal binge alcohol use, and a piecewise linear effect for gestational age revealed no clearly significant effects due to uncertainties associated with extreme and influential cases and small sample size, as discussed below.

Figures 1 and 2 are box plots of the MDI and PDI scores broken down by study group, maternal prenatal binge alcohol status, and a binary indicator of preterm birth. As can be seen from the box plots, all of the low scores truncated to 49 on the MDI (n = 3) and PDI (n = 6) were for children with either binge alcohol exposure or preterm birth.

Among the 76 children, 32 (42%) had mothers who reported prenatal binge alcohol use (30% of the HRC, 53% of the CRC, and 40% of the control group). We did observe a suggestion of an effect of maternal binge drinking on MDI and PDI scores, with offspring of these mothers having on average slightly lower scores.

An effect of preterm birth on MDI and PDI scores is suggested among mothers who did not report binge alcohol consumption. However, in all of the regression analyses, the significance of the gestational age factor depends entirely on the single subject with the lowest gestational age (26 weeks).

Corresponding analyses and box plots with the other main drug exposure variables (marijuana, heroin, and crack cocaine) show no hints of effects. Indicators of cigarettes, cocaine, and other street drugs were not considered in formal analyses because most of the mothers smoked cigarettes (71 of 78), most used cocaine (69 of 78), and only three reported use of other street drugs.

We observed no evidence of a systematic effect of the home visitation advocacy intervention on the child's MDI and PDI performance. The box plots suggest a possible intervention effect on MDI scores, but this approaches significance only after exclusion of the three lowest (truncated) MDI scaled scores. One of these three children was delivered at term with an encephalocele, to a mother who reported binge alcohol and almost daily cocaine use throughout pregnancy. Another, born at 34 weeks with Turner's syndrome and myotonic muscular dystrophy, was exposed to a month-long cocaine binge during the second trimester. The third was born preterm and prenatally exposed to cocaine and opiates.

DISCUSSION

The results of this study indicate that the developmental abilities of children prenatally exposed to alcohol and drugs were below age-expected levels of performance on

TABLE 3.

BSID-II: Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) among children in the hospital-recruited, community-recruited, and control groups at three years

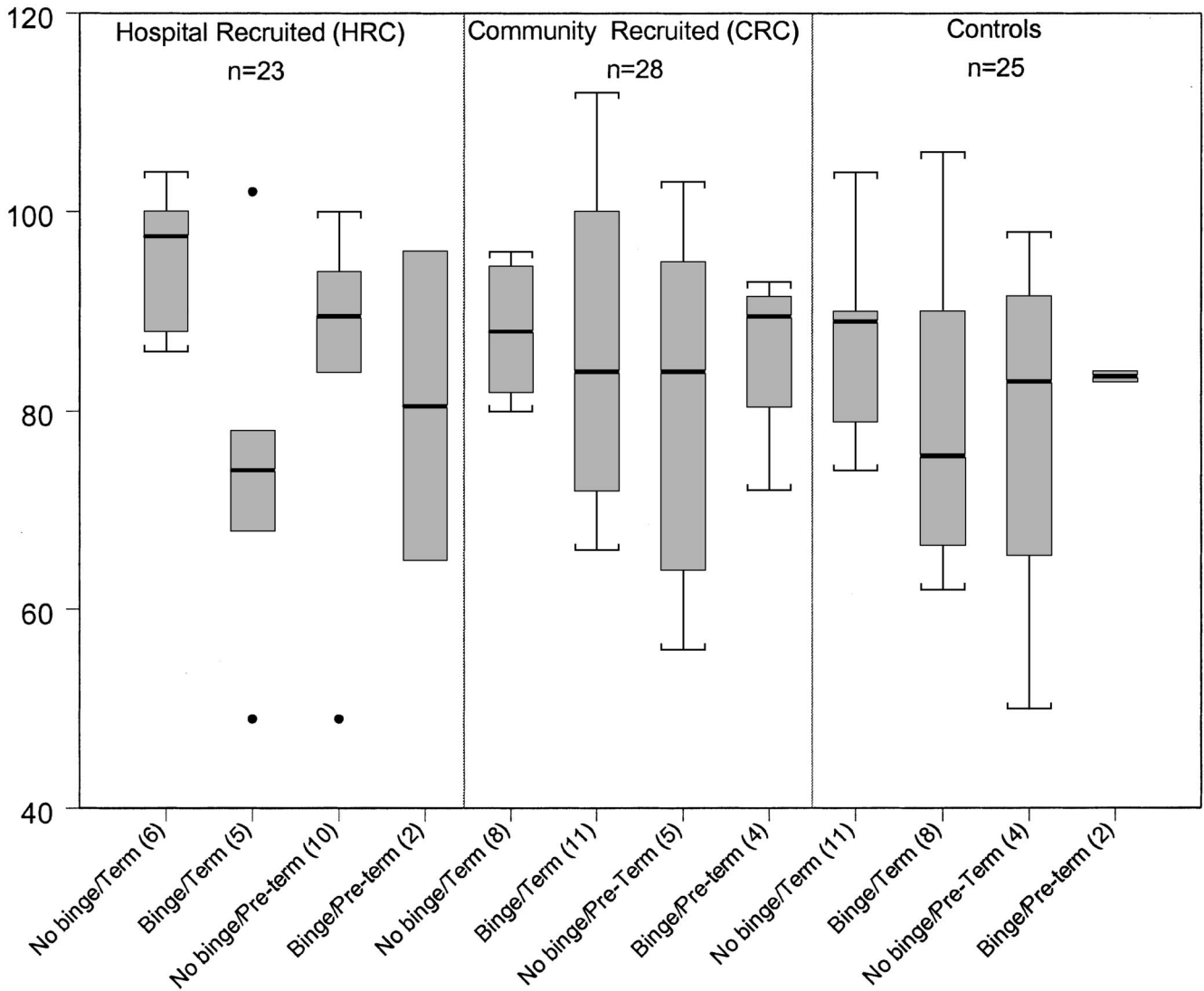| | Clients | | | Control Subjects | |
	Recruited from Hospital (n = 23)	Recruited from Community (n = 30)	Total Clients (n = 53)	Recruited from Hospital (n = 25)	Total Sample (n = 78)
MDI					
Mean (SD)	84.3 (17.4)	86.4 (13.4)	85.5 (15.1)	82.3 (12.8)	84.4 (14.4)
≤−1 SD, n	8	14	22	15	37
≤−2 SD, n	5	4	9	4	13
PDI					
Mean (SD)	77.8 (19.0)	89.6 (14.9)	84.5 (17.7)	83.4 (15.7)	84.1 (16.9)
≤−1 SD, n	16	10	26	14	40
≤−2 SD, n	9	3	12	3	15

MDI

Fig. 1. Box plots of BSID-II Mental Developmental Index (MDI) standard scores by study group, report of maternal prenatal binge alcohol use, and a binary indicator of prematurity. Circles represent extreme values that are (according to the conventional definition of a box plot) beyond the nearest quartile (upper or lower limit of the box) by a distance greater than 1.5 times the interquartile range (the length of the box). One of the circles for the HRC group (preterm/no binge) represents two subjects. Only 28 cases are represented in the CRC group because valid gestational ages were not available for two subjects.

mental, motor, and behavioral domains as measured by a standardized developmental assessment at three years of age regardless of study group or intervention status.

In contrast to several reports of children with similar exposures,[7,8,30] these findings suggest a developmental profile of greater concern. The first edition of the Bayley Scales of Infant Development[31] (BSID) was used to evaluate children in many of the earlier studies.[7,8,30]

Scores reported in the present study, as well as those reported by Alessandri et al,[32] were obtained using the BSID-II.[28] Scores in both of these studies were considerably lower than those reported in studies that assessed children using the BSID. Bayley reported only moderate correlations between the BSID and the BSID-II, with mean MDI and PDI scores on the BSID-II reported to be 12 points and seven

points lower, respectively, compared with the BSID.[28] Other researchers have also reported inflated BSID scores in comparison with BSID-II scores among children who experienced prenatal drug exposure.[9,33]

On the BRS, the behavior of 45% of the children in this study was characterized as either questionable or nonoptimal. Attention to task and task persistence were difficult for many of the children. We also observed problem behavior in self-regulation, social competence, and activity level among many of the children, observations consistent with other research reports of children exposed to multiple drugs prenatally.[13,14,34]

Whereas the BRS is a limited description of the child's behavior during a highly structured session, it does provide some insight. Limited or questionable competence in social
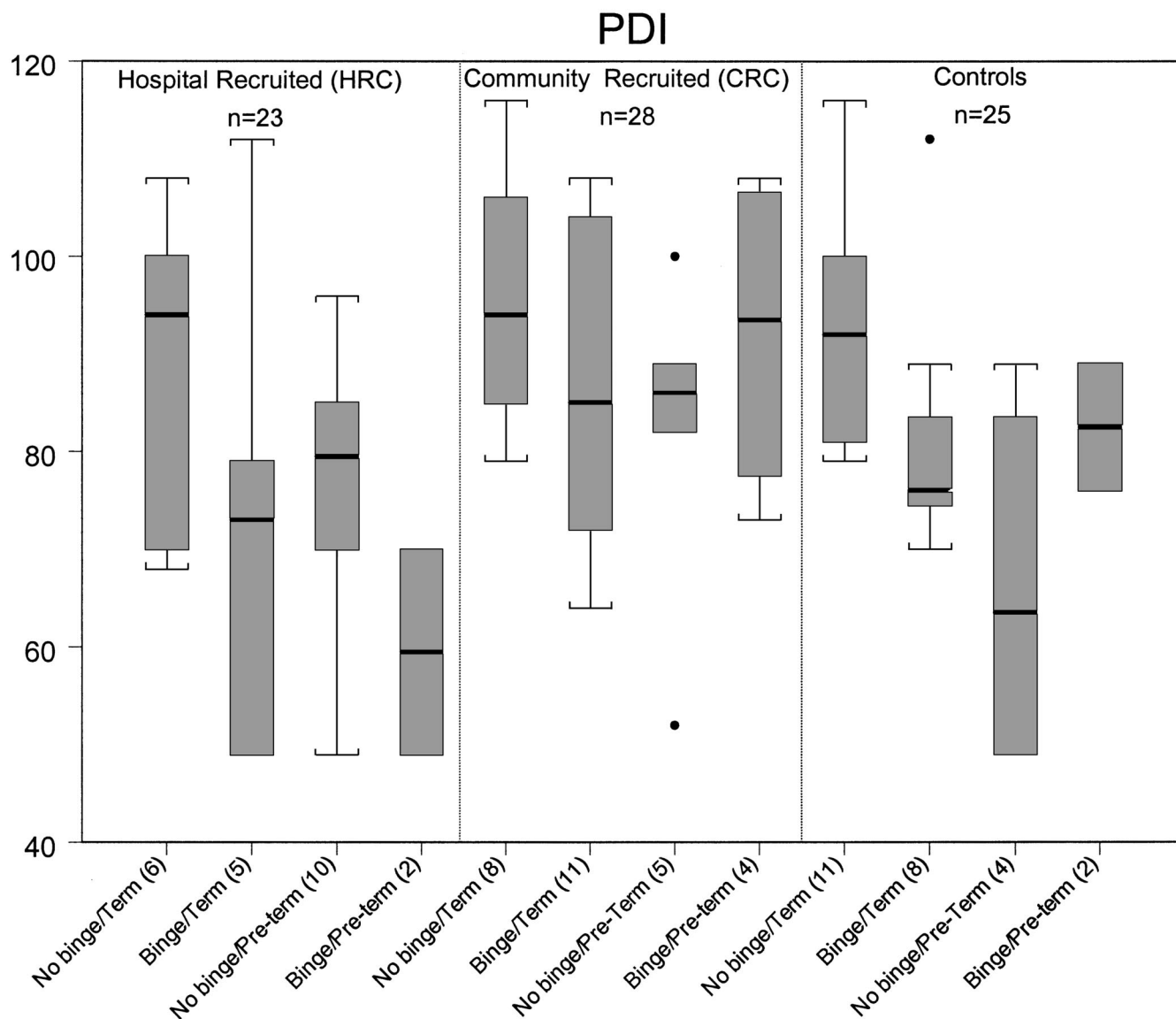
PDI

Fig. 2. Box plots of BSID-II Psychomotor Developmental Index (PDI) standard scores by study group, report of maternal prenatal binge alcohol use, and a binary indicator of prematurity. Circles represent extreme values that are (according to the conventional definition of a box plot) beyond the nearest quartile (upper or lower limit of the box) by a distance greater than 1.5 times the interquartile range (the length of the box). Each circle represents a single extreme value. Only 28 subjects are represented in the CRC group because valid gestational ages were not available for two subjects.

interaction, attention, self-regulation, and activity level will likely have a negative impact on the child's success in less structured environments (eg, at home, in daycare, or in preschool). Given the compromised BRS profile we observed under optimal assessment conditions, it is plausible that the children's functional performance in the "real world" would be even poorer than that predicted by their MDI and PDI scores.

Should the developmental trajectory of the children in the study persist into the school-age years, only about 17% would be eligible for special education and related services on the basis of their performance at or below −2 SD of the normative mean on the Mental Scale.[35] However, an additional 31% of children had marginal scores (between −2 SD and −1 SD on the MDI), indicating that they are at risk

for unsuccessful school experiences, although they would not automatically qualify for services. The unfortunate reality is that these children are unlikely to receive the help they need until a pattern of school failure has emerged.

Binge alcohol exposure[36] and preterm birth[37] are both associated with an increased risk of significant medical complications and developmental problems, but in this study the small sample size precluded our ability to detect potential statistically significant effects of these factors. In addition, only six (8%) children in this study had a gestational age less than 34 weeks, a threshold after which the incidence of complications associated with preterm birth may be similar to that of infants born at term.[38]

We observed only the suggestion of an effect of the home visitation intervention when truncated scores were

excluded. The Seattle Birth to 3 Program was a paraprofessional advocacy model designed to intervene with mothers at very high risk; it did not include a direct child developmental intervention component or a specific parenting curriculum. Published reports indicate that mothers who received the Birth to 3 Program intervention had significantly better outcomes compared with control subjects. They were more likely to complete substance abuse treatment, stay in recovery, use an effective family planning method, and obtain health and social services for themselves and their children.[26] Improvements such as these have a positive impact on the home environment and may contribute indirectly to more optimal development of a mother's children. However, intervention directed at compromised mothers is unlikely to have an effect on the developmental outcomes of children who have severe delays.

Limitations

Studies of children prenatally exposed to alcohol and drugs demonstrate the importance of extended follow-up to observe developmental effects over time.[3,8,13] Children in this study were tested only at age three, which may have limited the extent to which effects could be detected. The examiner was aware that all children in the study were prenatally exposed to alcohol or drugs. Examiner bias may have been introduced if assumptions held about the children's abilities influenced the examiner's scoring.

CONCLUSION

Our findings demonstrated that the developmental performance of children of preschool age who were exposed to alcohol and drugs prenatally was, on average, substantially lower than expected for age regardless of study group. Whether this exposure ultimately results in adverse long-term developmental outcomes for an individual child is likely a function of risk and protective factors that are intrinsic and extrinsic to the child. Home visitation intervention may be effective in helping a mother address a wide spectrum of needs and prevent another exposed pregnancy, but it is unlikely to be sufficient to overcome the complex developmental risks experienced by these children. More comprehensive, multidimensional services specifically designed for the child may be necessary.

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