Journal of Early Intervention. 2004
Vol 26. No. 3. 204–220
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REGULAR ARTICLE

# *Effects of Three Levels of Early Intervention Services on Children Prenatally Exposed to Cocaine*

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*Cocaine use during pregnancy is a high-risk indicator for adverse developmental outcomes. Three levels of intervention (center, home, and primary care) were compared in a full service, birth to age 3, early intervention program serving children exposed to cocaine prenatally. Data were collected on 130 children from urban, predominantly poor, primarily minority families. At 36 months, statistically significant, moderate to large intervention effects were found for cognition, receptive and expressive language, and gross motor development. Small effects were observed for behavior problems, and no statistically significant effects were found for fine motor or prosocial skills. Center-based care was most effective for improving language. These findings provide support that the center- and home-based early intervention programs examined in this study had positive effects on children at risk due to prenatal cocaine exposure.*

In utero cocaine exposure affects a significant number of children each year, with estimates ranging from 45,000 based on maternal self-report (National Institute of Drug Abuse [NIDA], 1996) to 375,000 based on hospital records (U.S. General Accounting Office [GAO], 1990). In the late 1980s to early 1990s, cocaine exposure became the focus of media and research efforts. The emphasis was on the hypothesis that cocaine affects children directly through biochemical processes during prenatal development (Chasnoff & Griffith, 1989), similar to other known teratogens such as alcohol. Indeed, most research efforts dealing with infants born to mothers who are substance abusing have focused on the effects of fetal exposure (Johnson & Leff, 1999). Early beliefs that exposure to cocaine during pregnancy caused significant direct neurological damage have not been substantiated, and whether the negative consequences are caused by the cocaine use or other related factors is still being debated (Frank, Augustyn, Grant Knight, Pell, & Zuckerman, 2001). A major problem with teasing apart whether or how cocaine might affect children is the significant presence of confounding risk factors (e.g., Frank et al., 2001; Lester, LaGasse, & Bigsby, 1998). Whether or not cocaine causes damage directly through toxic effect or indirectly through related risk factors is unclear, however, prenatal cocaine exposure indicates a high probability for the presence of other significant risks to the child's development.

A meta-analysis by Lester, LaGasse, and Seifer (1998) concluded that the effects of cocaine are more subtle than originally expected, but could still have damaging consequences for these children. Low IQ scores and, particularly, lower scores in language development have been documented (Chapman, 2000; Lester, LaGasse, & Seifer, 1998). Thus, children

prenatally exposed to cocaine represent a substantial increase in the number of school-age children in need of special education services (Johnson, 1997; Lester, LaGasse, & Bigsby, 1998).

Known risk factors linked to cocaine exposure include prenatal factors and postnatal environmental factors. Documented prenatal factors that might affect child development are poor nutrition and health, inadequate prenatal medical care, maternal smoking, and poly-drug use (Chan, Wingert, Wachsman, Schuetz, & Rogers, 1986; Hulse, English, Milne, Holman, & Bower, 1997). Cocaine exposure correlates with low birth weight, which in turn is associated with later developmental delays (Bendersky & Lewis, 1999; Hulse et al., 1997). Environmental risk factors associated with cocaine use in pregnant women include poverty, low maternal education, and exposure to violence (e.g., Hawley, Halle, Drasin, & Thomas, 1995; Lester, LaGasse, & Seifer, 1998; Mayes & Bornstein, 1996). Moreover, substance abuse is linked to various indicators of poor caregiving, including child maltreatment, unresponsiveness and neglect, unstable and inconsistent care, and insecure attachment, (e.g., Beeghly & Tronick, 1994; Kelley, 1998; Murphy, Jellinek, Quinn, & Smith, 1991; Rodning, Beckwith, & Howard, 1991). A large proportion of severe drug abusers experience poor mental health (Rounsaville et al., 1998) and were often victims of abuse themselves (Jantzen, Ball, Leventhal, & Schottenfeld, 1998; Johnson & Leff, 1999). The psychosocial risk factors associated with substance abuse make these mothers particularly ill prepared to parent a potentially developmentally vulnerable child (Nair et al., 1997).

Long-term studies that observed no differences between cocaine exposed and non-exposed samples from similar socioeconomic environments typically reported problems for both groups of children (e.g., Hurt, Malmud, Betancourt, Brodsky, & Giannetta, 2001; Phelps, Wallace, & Bontrager, 1997; Wasserman et al., 1998). Although these studies failed to detect specific effects of cocaine exposure, they document relatively poor outcomes for many of the children prenatally exposed to cocaine in cognitive, language, and behavioral development during preschool and early school years. These early problems place these children at risk for further problems (e.g., disturbances of language and behavior are stable predictors of later behavior disorders, including substance abuse; Dobkin, Tremblay, Masse, & Vitaro, 1995).

Regardless of the nature of the underlying processes by which cocaine affects development, children prenatally exposed to cocaine should be considered high-risk, and therefore, likely to benefit from intervention and prevention services (LaGasse, Seifer, & Lester, 1999; Lester, Boukydis, & Twomey, 2000). Few studies, however, have investigated early intervention for these infants. Nevertheless, the related literature on early intervention with young disadvantaged children provides considerable reason for optimism.

To yield optimal benefits it seems advisable to start intervention programs as early as possible (Lester et al., 2000). Although early intervention programs often serve children with identified disabilities, some programs have also focused on children who are at risk but not diagnosed as having a disability. In general, early intervention for children who are disadvantaged has been successful in improving language and cognitive status while decreasing behavior problems (Infant Health & Development Program, 1990; Martin, Ramey, & Ramey, 1990; Warr-Leeper, 2001). Although the evidence for long-term effectiveness of programs for children at risk is modest (Halpern, 2000), some data demonstrate improvements in children's language, social interactions, and intellectual development for multidisciplinary, individualized, and contextually embedded programs (Ramey, Campbell, & Ramey, 1999). Programs that are effective in improving child outcomes tend to be center based (Warr-Leeper, 2001). No studies have directly compared center versus home interventions for children who are disadvantaged.

No data are available on the effectiveness of center-based early intervention programs with children who have been exposed to substances prenatally. Previous early intervention

*Table 1.*
*Overview of the Three Levels of Intervention*

| | Center-based | Home-based | Primary care |
|---|---|---|---|
| Intervention services | • Curriculum-based intervention in the classroom<br>• 1:3 adult-child ratio<br>• 5 days per week for 5 hours per day | • Curriculum-based intervention in the home<br>• One-on-one<br>• 2 days per week for 1.5 hours | *None* |
| Support services | • Daily nutrition<br>• Medical care<br>• Social work services<br>• Family support<br>• Transportation to appointments and daily transportation | • Medical care<br>• Social work services<br>• Family support<br>• Transportation to appointments | • Medical care<br>• Social work services<br>• Family support<br>• Transportation to appointments |

with these infants has focused on home visiting. Home visits tend to affect parenting rather than child development (Black et al., 1994). Long-term effectiveness of home visit programs in populations at risk have been reported (Olds et al., 1999), although the effectiveness in studies of women who abuse substances is not consistent. One program was not effective in changing mother-child interaction (Schuler, Nair, Black, & Kettinger, 2000) whereas a different home visit program improved parenting and child behavior problems (Butz et al., 2001).

The Linda Ray Intervention Project (LRIP) was founded, in part, to examine the effectiveness of three levels of early intervention services on children at risk due to prenatal exposure to cocaine.

## *Development of the Project*

The project was conceptualized using a public health model, emphasizing a risk-focused strategy (Scott, Hollomon, Claussen, & Katz, 1998). The strategy was to select an adverse outcome to target (e.g., poor language development), identify the sources of risk associated with this outcome (e.g., limited exposure to reading material in the second year), design a strategy to prevent risk occurrence, and then develop an intervention component.

*Overview of the intervention services.* The LRIP was designed to evaluate three programs varying in intensity of services implemented for children from birth through age 3. The three levels from least to greatest intensity were (a) primary care, which involved comprehensive social work services, primary medical care, and scheduled developmental assessments; (b) home-based, which provided all primary care services plus two 1.5 hr child-focused home visits by a teacher per week; and (c) center-based, which also provided primary care services plus center-based early intervention for children for 5 hr per day, 5 days per week. Table 1 shows an overview of the three programs.

*Needs assessment.* To develop the intervention model, a needs assessment was conducted using research evidence and assessment of the environment experienced by children exposed to cocaine in Miami-Dade County (Scott et al., 1998). The purpose of the intervention was to prevent later developmental problems, thus the primary need was appropriate developmental stimulation. An initial decision was made to focus on the child as the primary intervention target and to provide intervention directly to the child. To ensure permanent success, changes in the home environment would be most optimal. Indeed, some interventions aimed at mothers have resulted in improved child outcomes (Field et al., 1998). A program focused on substance-abusing mothers as the client, how-

ever, would have to be centered on treating drug addiction, which usually is successful in only the minority of cases (Blackwell, Kirkhart, Schmitt, & Kaiser, 1998). Drug treatment programs for mothers already existed in the community, but no services for the children were available. Children whose mothers dropped out of drug treatment presumably would be lost to the intervention although they were the most likely to need it (Blackwell et al., 1998; Brown, Melchior, & Huba, 1999). Moreover, mothers who use substances during pregnancy often lose custody and children are placed in relative or foster care, (Hawley et al., 1995; Kelley, 1992) experiencing repeated changes in caregiving with continued need for services (McCarty, Waterman, Burge, & Edelstein, 1999). Thus, the child was conceptualized as the primary client within the LRIP (Scott, Urbano, & Boussy, 1991).

Children were included in the program regardless of custody placement or frequent moves; the only limiting factor was geographical location within the program's catchment area. The program maintains an ecological approach (Thurman & Berry, 1992), addressing family and contextual risk factors by coordinating intervention services with drug treatment and parent support without making those components mandatory.

*Description of intervention services.* Developmental stimulation needed to be geared to the child's individual needs. Because no specific cocaine syndrome exists, a variety of developmental delays could be expected. A curriculum was needed that addressed all major developmental areas and was adaptable to serve each child's individual needs. The Outcome curriculum (Scott & Scott, 1992) was adopted, which is developmentally sequenced and based on major milestones of children who are typically developing rather than on a deficit model. The Outcome curriculum includes activities organized in the domains of social/emotional, language, cognitive, fine motor, gross motor, and self-help development (Scott et al., 1998). Each activity is organized around the headings "why," "when," "what to do," and "what will happen." In addition, to maximize parent support for appropriate stimulation, the curriculum was geared to parents with potentially low literacy by using simple language and illustrations.

The curriculum was applied in both center- and home-based programs. The services were centered on teachers providing direct intervention with the child. Parents were offered the curriculum and opportunities to observe. Few center-based parents, however, ever came to observe or participate in the classrooms, and home-based parents' involvement varied, with parents typically participating only for portions of the time the teacher spent at the home. This approach differed from previous home-visiting programs working directly with the parent (e.g., Butz et al., 2001; Schuler et al., 2000).

The intervention was funded by Miami-Dade County Public Schools (MDCPS), and had to meet the standards for developmentally appropriate practices for early intervention programs for children with developmental delays. Both intervention groups were periodically evaluated and supervised by MDCPS.

*Center-based services.* In addition to utilizing the Outcome curriculum, the center intervention program incorporated the High/Scope curriculum framework (Weikart, 1979) mandated by the school district, including a child-initiated approach, indoor and outdoor play times, activity centers, and a 1:3 teacher-child ratio. To access the center-based intervention, transportation was critical (Grant, Ernst, & Streissguth, 1996), because the likelihood of reliable transportation decreased with increased risk and poverty. In addition, a predictable daily routine was important to maintain. In the mornings, children were transported to the center by classroom assistants and served breakfast at 9 a.m. Two hours of small and large group activities in the classroom and outdoor play followed, with classrooms also taking turns in art, functional play, and symbolic play areas. Lunch was provided, followed by 1 hr of nap time and more group play. Thus, center-based children were provided appropriate nutrition, an important service due to poor nutritional choices often made by their caregivers (Butz, Lears, O'Neil, & Lukk,

1998). Children were transported to their home or other day care centers after dismissal at 2 p.m. All children enrolled in the intervention were prenatally exposed to cocaine; thus, classrooms were self-contained.

An important need addressed by the intervention was the lack of stable supportive caregivers because of frequent moves and custody changes. Children were assigned to the same teachers for the duration of the intervention, rather than moved from infant to toddler to preschool classrooms. The purpose was to strengthen the children's bond with their teachers as a secondary attachment figure (Raikes, 1993).

*Home-based services.* The home-based services involved two 1.5 hr visits per week at the child's home between 9 a.m. and 5 p.m. Teachers brought developmentally appropriate toys and primary caregivers were invited to participate. Home-based visits typically included books, music, physical play, toy play, and if possible, outdoor play. When necessary, teachers integrated their intervention into the daily life of the children by incorporating feeding or bath times, and by accommodating other children present in the home.

*Comprehensive services.* In addition to intervention with the children, and to make the intervention possible, comprehensive secondary services were available (Brindis, Berkowitz, Clayson, & Lamb, 1997). These services were provided to all three groups including the primary care group. Such secondary services typically were not available in the community on a systematic basis.

Comprehensive secondary services must be well organized, because high levels of life stress combined with low skills can make it difficult for these families to manage service coordination. Thus, LRIP was conceptualized as a one-stop total service intervention program designed to provide critical early intervention services either directly or by dovetailing with existing services in the community (Scott et al., 1998). To enable access to services, we provided transportation to medical, social work, and developmental assessment appointments.

Social work services were needed to facilitate coping skills for families dealing with life stress associated with poverty. Two social workers coordinated families' needs through intensive case management and provided referrals to ancillary services, such as job training, housing, other financial assistance, and mental health interventions. Families were encouraged to utilize these services from the time of enrollment. In addition, social workers approached families in cases where intervention or research staff identified a need. For mothers who did not yet receive needed drug treatment (Butz et al., 1998), we collaborated with several treatment providers, most of whom had recently developed special programs for mothers. These programs did not have any services for children beyond babysitting; thus, our program was complementary to their services. We also developed support groups for relative caregivers such as grandmothers and fathers.

An important need was creating a primary medical care home for these families (Butz et al., 1998; Mayes & Bornstein, 1996) who often underutilize medical services or use emergency care routinely (Chan et al., 1986). A collaborating University of Miami community-based pediatric practice provided well-child services to children and their siblings. Systematic medical care can monitor conditions that contribute directly to poor outcomes (e.g., otitis media via language delays) or indirectly through absenteeism from intervention and exposure to risks such as neglect (e.g., poor nutrition) or abuse. By integrating social, medical, and educational services we developed long-term relations with these families. This contrasted with the crisis intervention approach characterizing many of the available services in this community.

The purpose of the study was to examine the effect of the three levels of intervention on preventing developmental delays in cognition, language, motor skills, and behavior problems. The hypothesis was that the most intensive intervention, center-based, would result in the most optimal scores and least number of children with delays, whereas the least intensive intervention, primary care, would

result in the least optimal scores and most number of children with delays.

## METHOD

### Participants

The sample consisted of 130 children who were 72% ($n$ = 94) African American, 10% ($n$ = 13) Hispanic, 8% ($n$ = 10) Caucasian, 2% ($n$ = 3) Haitian, and 8% ($n$ = 10) multiple race/ethnicity. Fifty-five percent ($n$ = 72) were girls. Families were predominantly poor; 85% ($n$ = 110) received some form of public assistance (e.g., Aid for Families with Dependent Children [AFDC], food stamps, or assistance from Women, Infants and Children [WIC]). Homes were unstable; 89% of the children moved at least once between birth and 3 years of age ($M$ = 3 moves, range = 0 to 12 moves). Approximately 67% of children changed custody at least once ($M$ = 1.5 custody changes, range = 0 to 8).

*Referral sources.* Referrals were solicited from a variety of sources including: (a) the Maternal Lifestyle Study, a research program investigating the effects of prenatal drug use; (b) drug treatment facilities; (c) social workers from the state of Florida's child protective services (DCF); (d) public health nurses assigned specifically to monitor infants who were substance exposed; and (e) discharge planning coordinators at the University of Miami Jackson hospital. After the program had been established, we also received some self-referrals.

*Enrollment criteria.* The primary inclusion criterion was prenatal cocaine exposure, detected through drug testing at birth or maternal self-admission, and residence in the catchment area of the project. This area was based on transportation, because no more than a 45-min bus ride at maximum was considered appropriate for daily transport of infants. The catchment area includes predominantly urban low-income or poor communities. In some cases, center-based children who moved out of the catchment area were provided home-based services, but were not counted for random assignment. Home-based children who moved out of the catchment area within the county continued to be served, because no daily transportation was involved. Infants were excluded and referred to more intensive early intervention programs if major physical, neurological, or medical problems were present because the I.RIC program could not offer physical or occupational therapy or on-site nursing care.

*Group assignment.* For both ethical and practical reasons, home and center groups were randomly assigned but the primary care group was formed from a waiting list after the capacity of the facility and funding level was maximized. Two reasons for this procedure were (a) children were enrolled based on their risk for delays, and it was not considered ethical to deny services to achieve random selection; and (b) reimbursement for intervention was based on numbers of children served. To cover fixed overhead and staff costs, rapid enrollment of children was required. Therefore, children were randomly assigned to either center- or home-based intervention until all 60 spaces in each program were taken. The subsequent 60 referrals were then assigned to the primary care group.

Referrals were sought for children birth to 6 months-of-age. For center- and home-based groups, intervention began after official enrollment into the Dade County Public Schools program for children birth to age 2 (mean age = 3.8 months, $SD$ = 2.3). In comparison, for children in the primary care group, the mean age of first participation in developmental assessments was 12.5 months ($SD$ = 9.5, range = 6–36 months). Only 18 of these children began attending during the 6-month assessment, and, three children attended only the 36-month assessment. Further, nine children older than 18 months-of-age were enrolled into the center program to replace age equivalent children who moved, but these cases were not included in the analyses.

*Attrition.* As expected for families with high-risk, attrition was a factor. Primarily, sources of attrition were moves and lack of follow-through after the initial referral. Although there was cooperation from the state child welfare agency, follow-through with individual caseworkers varied greatly, ranging

from some caseworkers actively providing information to others failing to respond to our inquiries. Of 222 referred cases, 27 children never enrolled, 47 children (specifically, 14 center, 17 home, and 16 primary care) left the program after initially participating, 29 children moved, 18 children could not be found or withdrew, and 7 children (specifically, 4 center and 3 home) were referred to more intensive programs because they required physical or occupational therapy. In addition, 11 children were excluded from analyses because they were siblings of previously enrolled children, resulting in a final sample of 130 children. Data were available on 50 center-based, 46 home-based, and 34 primary care children.

### Procedure

Child developmental assessments were conducted during regularly scheduled visits at the intervention center. The assessments were conducted by trained research assistants. Due to limited funds, only one third of the assessments were conducted by assessors blind to group status. No mean differences in scores between blind and nonblind assessors were found. The present study reports on the outcome assessments conducted at 36 months-of-age at the center ($M$ = 36 months, $SD$ = 0.7). Children were administered three standardized tests: the Bayley Scales of Infant Development (BSID-II; Bayley, 1994), the Reynell Developmental Language Scales (RDLS; Reynell & Gruber, 1990), and the Peabody Developmental Motor Scales (PMDS; Folio & Fewell, 1983). Parents were asked to complete the Child Behavior Problem Checklist (CBCL/2–3; Achenbach, 1992), and the Adaptive Social Behavior Inventory (ASBI; Hogan, Scott, & Bauer, 1992).

### Measures

*General cognitive development.* The Mental Scale of the Bayley Scales of Infant Development (Bayley-II, 1994) was used as an index of general cognitive development. This is a commonly used, standardized developmental assessment for children ages birth to 4 years. The Bayley-II yields a mental age estimate and a standardized estimate of cognitive development, or Mental Development Index (MDI), with a mean of 100 and standard deviation of 15. The scale was standardized using a sample of 1,700 infants and children between the ages of 1 and 42 months, closely approximating the regional distribution and ethnicity of children identified in the 1988 U.S. Census.

*Language development.* The RDLS (Reynell & Gruber, 1990) consists of a 118-item standardized assessment, yielding receptive and expressive language quotient scores. The scales were originally developed in England, however, a revised version of the Reynell with data on a normative sample of 619 children from the United States was used. The sample included children from 1 year to 6 years, 11 months of age (83.5% White, 10.0% Black, 4.9% Hispanic, 1.6% Asian) equally distributed across the geographic areas of the U.S. This version of the Reynell reports adequate reliability and validity of scores based on normative sample data (Reynell & Gruber, 1990).

*Motor development.* The PDMS is a standardized and norm-referenced test administered individually to children from birth through 83 months (Folio & Fewell, 1983). The test contains both a Gross-Motor Scale and a Fine-Motor Scale. Each test item is scored on a 3-point scale with full credit given for pass, no credit for fail, and partial credit for emerging behavior. The PDMS was normed on a total of 617 children (1 month to 7 years) in 20 states throughout the U.S., stratified by geographical region, gender, and race (85.1% Anglo, 7.3% Black, 7.6% Hispanic). Both test-retest and interrater reliability score correlations have been reported at above .90 for this normative sample. Because of time constraints, these two assessments were conducted for only 108 of the 130 children.

*Behavior.* The CBCL consists of 99 items for which a reporter indicates whether the item is *very true, somewhat true,* or *not true* of the child. Items are combined to form six scales with raw and $t$-scores including Anxious/Depressed, Withdrawn, Sleep Problems, Somatic Complaints, Aggressive, and Destructive. All scales are combined to form a

Total scale. Scores from the CBCL/2–3 have been shown to have adequate reliability and validity for a normative sample of 368 children 2 to 3 years of age (73% Caucasian, 16% African American, 7% Latino, 3% Other Ethnicities), throughout the U.S. (Achenbach, 1992).

Prosocial behaviors were measured using parent report on the ASBI (Hogan et al., 1992), a 30-item measure consisting of three scales. The Express scale indicates the degree to which a child joins play with others, the Comply scale indicates compliance with adult directives, and disruptive behavior is measured using the Disrupt scale. The inventory was developed specifically for a multi-ethnic at-risk sample who resided in approximately the same catchment area and thus were from similar social environments as the current sample (Hogan et al., 1992). Internal consistency reliability (Cronbach's alpha) for this sample, was .79 for the Express and Comply scales and .71 for the shorter Disrupt scale. Fourteen of 130 parents did not complete the behavior questionnaires.

## *RESULTS*

### *Descriptive Statistics*

Overall, for all three groups combined, the sample means at age 3 were near or in the at-risk range for most of the standardized outcome measures: Bayley-II MDI = 86.64 (*SD* = 12.03); RDLS receptive score = 80.09 (*SD* = 13.52); RDLS expressive score = 79.01 (*SD* = 14.04); and PDMS fine motor score = 86.64 (*SD* = 14.94). The mean PDMS gross motor score (95.03; *SD* = 16.06) and the CBCL total problem *t*-score (*t* = 53.44; *SD* = 12.63), however, were within the normal range. To examine proportions of children with delays in the total sample, cognitive and language scores were coded low if they were 1.5 standard deviations below 100, or for the behavior problem measure if the *t*-scores were above 60. Of the sample, 19% scored delayed in cognition, 48% in receptive language, 53% in expressive language, 16% in gross motor skills, 35% in fine motor skills, and 25% in behavior problems.

To examine attrition effects, available data on race/ethnicity, level of public aid, and developmental status at enrollment using the PDMS were compared for children included in the outcome study and those who moved or left the program. Motor development was assessed at program entry because at the time this study was developed, motor impairments such as hyper- and hypotonicity were thought to be the primary presenting problem for infants who were substance exposed. An alpha level of .05 was used for this and all other statistical tests. None of the analyses of variance or $\chi^2$ statistics were statistically significant, with the exception of race/ethnicity. Children who left the study were significantly more likely to be Caucasian than those included (26% vs. 8%).

Center, home, and primary care cases were also compared on demographic variables to examine whether the group assignment procedure resulted in comparable groups (see Table 2). Statistically significant differences were found for number of moves, indicating that center-based children experienced the most instability, but the groups were otherwise similar (see Table 3).

*Attendance.* Days of program attendance was recorded for center- and home-based groups. Mean attendance was 279 days for center (*SD* = 30.1, range = 207–315) and 172 days for home (*SD* = 28.9, range = 95–215).

### *Effects of Intervention at 36 Months-of-Age*

*Cognition.* For the Bayley test, analysis of variance indicated that the differences among the three groups on MDI scores were statistically significant, $F(2, 127) = 4.94$, $p = .009$. Center-based children had the highest scores, home-based children the second highest, and primary care children the lowest scores. A priori contrasts showed statistically significant differences between intervention groups and primary care, $t(128) = 2.75$, $p = .007$, but not between center- and home-based groups (see Table 4). Analyses of the effect size of the intervention using Glass's delta (Glass, 1976) showed a small effect of center compared to home intervention; the effect between center

*Table 2.*
*Comparison among Intervention Groups on Demographic Variables*

| | Intervention group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Center | | Home | | Primary care | | | |
| | *n* | % | *n* | % | *n* | % | $\chi^2$ | *p* |
| Gender | | | | | | | | |
| Female | 27 | (38%) | 26 | (36%) | 18 | (26%) | | |
| Male | 23 | (40%) | 20 | (34%) | 15 | (26%) | .066 | .97 |
| Race/ethnicity | | | | | | | | |
| African-American | 36 | (38%) | 30 | (32%) | 28 | (30%) | 2.87[a] | .24 |
| White | 2 | (20%) | 7 | (70%) | 1 | (10%) | | |
| Mixed race/ ethnicity | 5 | (50%) | 2 | (20%) | 3 | (30%) | | |
| Hispanic | 4 | (31%) | 7 | (54%) | 2 | (15%) | | |
| Haitian | 3 | (100%) | — | | — | | | |
| Public aid | 35 | (40%) | 34 | (36%) | 23 | (26%) | 1.14 | .56 |
| No public aid | 6 | (30%) | 7 | (35%) | 7 | (35%) | | |

[a]Due to the small cell sizes, the $\chi^2$ compared African American versus all other racial/ethnic groups.

and primary care was moderate to large, and the effect of home compared to primary care was small to moderate (see Table 5).

*Language.* A multivariate analysis of variance was conducted for receptive and expressive language using the Reynell scores. Differences among the three groups were statistically significant $F(4, 248) = 4.61$, $p = .001$. Individual analyses of variance showed statistical differences among the three groups on receptive, $F(2, 127) = 4.59$, $p = .01$, and expressive language scores, $F(2, 126) = 9.85$, $p < .001$. The planned contrasts between intervention groups and primary care were statistically significant for expressive, $t(124) = 2.23$, $p = .03$, but not for receptive language, $t(125) = 1.85$, $p = .07$. Differences between center and home were statistically significant for receptive, $t(125) = 2.36$, $p = .02$, and expressive language, $t(124) = 3.79$, $p < .001$. Center-based children had the highest scores; home-based and primary care children had similarly low scores (see Table 4). Post hoc analyses showed no statistically significant differences between home and primary care groups, so the intervention effect was explained by the center group alone. When investigating effect size for center versus home or primary care, intervention effects were moderate for receptive language and large for

*Table 3.*
*Comparison among Intervention Groups on Demographic and Developmental Characteristics*

| | Intervention group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Center | | Home | | Primary care | | | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *t* | *p* |
| Moves | 3.6 | (2.7) | 2.5 | (2.1) | 2.3 | (2.3) | 4.40 | .01 |
| Custody changes | 1.8 | (1.9) | 1.1 | (1.2) | 1.4 | (1.3) | 2.65 | .08 |
| PDMS Gross Motor | 93.6 | (17.8) | 93.2 | (16.9) | 96.2 | (15.0) | .21 | .81 |
| PDMS Fine Motor | 98.2 | (15.8) | 97.2 | (16.5) | 100.4 | (17.9) | .23 | .79 |

*Note.* PDMS = Peabody Developmental Motor Scales.

*Table 4.*
*Means and Standard Deviations of Outcome Variables for Intervention Groups*

| | Intervention group | | | | | |
|---|---|---|---|---|---|---|
| | Center | | Home | | Primary care | |
| | *M* (95% *CI*) | *SD* | *M* (95% *CI*) | *SD* | *M* (95% *CI*) | *SD* |
| Bayley-II MDI | 90.0 (86.7–93.2) | 11.5 | 86.5 (82.9–90.1) | 12.3 | 81.8 (77.9–85.7) | 11.2 |
| RDLS Receptive | 84.5 (80.4–88.6) | 14.2 | 78.1 (74.5–81.7) | 12.0 | 76.4 (71.9–81.0) | 13.1 |
| RDLS Expressive | 85.5 (81.4–89.7) | 14.4 | 75.2 (71.5–79.0) | 12.6 | 74.5 (70.2–78.7) | 11.9 |
| PDMS Gross Motor | 99.2 (94.5–103.9) | 15.6 | 95.1 (88.8–101.5) | 17.6 | 88.5 (83.5–93.4) | 13.0 |
| PDMS Fine Motor | 87.5 (82.8–92.2) | 15.7 | 85.7 (80.2–91.2) | 15.3 | 86.3 (81.2–91.5) | 13.5 |
| CBCL | | | | | | |
| Anxiety | 5.8 (4.8–6.7) | 3.2 | 5.6 (4.5–6.8) | 3.5 | 6.8 (5.1–8.6) | 5.1 |
| Withdrawal | 4.6 (3.5–5.8) | 4.0 | 4.9 (3.8–5.9) | 3.2 | 7.0 (4.9–9.1) | 6.0 |
| Sleep problems | 2.8 (2.1–3.6) | 2.5 | 3.7 (2.6–4.8) | 3.4 | 4.4 (3.4–5.4) | 2.8 |
| Somatization | 3.0 (2.1–3.9) | 3.1 | 2.9 (2.1–3.7) | 2.4 | 3.8 (2.9–4.7) | 2.7 |
| Aggression | 9.4 (7.7–11.0) | 5.6 | 10.5 (8.2–12.7) | 6.7 | 11.4 (9.2–13.6) | 6.3 |
| Destructiveness | 4.7 (4.0–5.7) | 3.2 | 5.0 (4.1–5.9) | 2.6 | 6.2 (4.7–7.8) | 4.5 |
| Other | 7.7 (6.1–9.3) | 5.6 | 8.8 (6.8–10.8) | 5.9 | 11.6 (8.7–14.5) | 8.4 |
| Total | 38.0 (31.5–44.6) | 22.6 | 41.6 (33.8–49.3) | 22.6 | 51.2 (40.2–62.1) | 31.5 |
| ASBI | | | | | | |
| Expressiveness | 33.4 (32.3–34.6) | 4.1 | 34.1 (33.0–35.1) | 3.3 | 33.0 (31.5–34.5) | 4.0 |
| Compliance | 22.2 (21.2–23.1) | 3.2 | 21.9 (20.8–23.0) | 3.5 | 22.2 (20.7–23.8) | 4.0 |
| Disruptiveness | 11.1 (10.5–11.8) | 2.2 | 12.0 (11.0–12.9) | 2.8 | 11.9 (11.0–12.9) | 2.5 |

*Note.* Bayley-II MDI = Bayley Scales of Infant Development-II Mental Development Index; RDLS = Reynell Developmental Language Scales; PDMS = Peabody Developmental Motor Scales; CBCL = Child Behavior Problem Checklist; ASBI = Adaptive Social Behavior Inventory

expressive language, whereas effect sizes for the differences between home and primary care were less than 0.2 (see Table 4).

*Motor skills.* A multivariate analysis of variance revealed that the mean motor scores among the three groups were statistically different, $F(4, 204) = 2.67$, $p = .03$. Univariate analyses showed statistically significant differences for gross motor skills, $F(2, 105) = 4.15$, $p = .02$. Specifically, the intervention groups scored higher than the primary care group, $t(103) = 2.54$, $p = .01$ (see Table 4).

*Table 5.*
*Effect Sizes for Intervention Effects: Glass's Delta*

| | Intervention group | | |
|---|---|---|---|
| | Center vs home | Center vs primary care | Home vs primary care |
| Bayley-II MDI | .28 | .73 | .42 |
| RDLS Receptive | .53 | .62 | .13 |
| RDLS Expressive | .82 | .92 | .06 |
| PDMS Gross Motor | .23 | .82 | .51 |
| PDMS Fine Motor | .12 | .09 | .04 |
| CBCL | | | |
| Anxiety | .06 | .20 | .24 |
| Withdrawal | .09 | .40 | .35 |
| Sleep problems | .26 | .57 | .25 |
| Somatization | .04 | .30 | .33 |
| Aggression | .16 | .32 | .14 |
| Destructiveness | .12 | .33 | .27 |
| Other | .19 | .46 | .33 |
| Total | .16 | .41 | .30 |
| ASBI | | | |
| Expressiveness | .21 | .10 | .27 |
| Disruptiveness | .32 | .32 | .04 |
| Compliance | .09 | .00 | .08 |

*Note* Bayley-II MDI = Bayley Scales of Infant Development-II Mental Development Index; RDLS = Reynell Developmental Language Scales; PDMS = Peabody Developmental Motor Scales; CBCL = Child Behavior Problem Checklist; ASBI = Adaptive Social Behavior Inventory

The difference between center- and home-based groups on gross motor scores was not statistically significant. Calculation of effect sizes showed a large effect for center versus primary care, a moderate effect for home versus primary care, and a small effect for center versus home. On fine motor skills, mean scores were not statistically different among the groups, and effect sizes were less than 0.2 (see Tables 4 and 5).

*Behavior scores.* An analysis of variance of the CBCL scores showed that the differences among intervention groups on total behavior problems were not statistically significant, $F(2, 114) = 2.71$, $p = .07$. Of the seven individual scales, only differences for withdrawal, $F(2, 114) = 3.06$, $p = .05$, sleeping problems, $F(2, 114) = 2.90$, $p = .05$, and other behavior problems, $F(2, 114) = 3.58$, $p = .03$, were statistically significant. A priori analyses showed statistically significant differences for intervention versus primary care on total score, $t(115) = -2.18$, $p = .03$, withdrawal, $t(115) = -2.44$, $p = .02$, and other behavior problems, $t(115) = -2.50$, $p = .014$. These tests found statistically significant differences for anxiety, $t(115) = -1.4$, $p = .16$; aggressiveness $t(115) = -1.18$, $p = .24$; destructiveness, $t(115) = -1.89$, $p = .06$; somatization, $t(115) = -1.46$, $p = .15$; or sleeping problems, $t(116) = -1.92$, $p = .06$. Calculations of effect sizes showed that the differences of the mean scores between center and primary care ranged from small (.20) to moderate (.57). For home versus primary care, most effects were around .30, with the exception of aggression (<.2). The effects of center versus home were less than .2 for all scales except sleep problems (.26; see Table 5).

On the ASBI mean scores, no statistically significant differences were found to be associated with any of the analyses comparing intervention levels (see Table 4). Calculation of effect sizes showed a small effect for center

compared to home or primary care on the Disruptiveness subscale and a small effects for center versus home and home versus primary care on the Expressiveness subscale (see Table 5). Virtually no effect was found for the Compliance subscale.

## DISCUSSION

### Effects of Intervention

These results support the efficacy of intervention with children prenatally exposed to cocaine. Both interventions had measurable effects on child development at 36 months-of-age, similar to intervention with other at-risk groups (Infant Health & Development Program, 1990). Furthermore, the data provide evidence of greater effects for the more intensive center-based compared to home-based intervention, particularly in the area of language development. Overall, center-based children performed most optimally on the outcome measures, whereas primary care children performed least optimally. Intervention services were more effective than primary care services for improving cognition, language, and gross motor skills, but not fine motor skills. This study also provides some support for the effectiveness of intervention in preventing behavior problems (Infant Health & Development Program, 1990).

The data suggest that children prenatally exposed to cocaine are at risk for developmental delays and problems across a range of outcomes. For cognition, the mean standardized scores were in the normal range (within one standard deviation from the mean) only for the center-based group; the home-based group mean was at the borderline to at-risk range. Based on the assessments used for our study, the most significant area of delay across all groups was in language, with means near the at-risk range for the center-based group and in the at-risk range for home and primary care groups. In previous studies, language delays have been of particular concern in children exposed to cocaine (Chapman, 2000; Johnson, 1997; Lester, LaGasse, & Seifer, 1998). These potential prenatal effects are likely to be compounded by the effects of the deprived environment associated with low socio-economic homes, often characterized by low language input, low maternal education, and lack of consistent positive interactions between children and caregivers.

Gross motor skills on average seemed to be more normative, however, fine motor skills were delayed in this sample. Motor deficits have been predicted for cocaine exposed children (Arendt, Minnes, & Singer, 1996), although evidence is inconclusive (Frank et al., 2001). It is unclear why no intervention effects were found for fine motor skills despite the fact that fine motor activities were addressed systematically as part of the intervention. Although statistically significant numbers of parents reported high levels of behavior problems (21% and 35% for intervention and control groups, respectively), the average *t*-score (53) does not point to pervasive behavior problems in this sample as predicted by early studies of prenatal cocaine exposure (Scherling, 1994).

### Home versus Center

Compared to primary care, the center-based program resulted in moderate to large effects on several of the outcome measures, whereas the home-based showed some small to moderate effects on child development. When comparing center and home interventions, the data show that both were similarly effective in relation to cognition and behavior. Regarding language development, however, only center-based intervention had a large effect on expressive language skills, and moderate effects on receptive language skills when compared to primary care, whereas the effect of home-based intervention was small. A possible influence was inherent differences in the amount of intervention. Specifically, for cognitive skills, it might have been sufficient to receive intensive one-on-one intervention for 3 hr per week, whereas for language skills these 3 hr of child-focused language were not a sufficiently large enough dose to result in noticeable changes. For cognitive skills, children who receive intensive instructions for periodic, short terms might be able to practice and maintain such skills on their own, whereas for

language, continued exposure to appropriate input might be necessary.

A parent interaction-focused rather than a child-focused intervention might be necessary to result in significant language improvement in a home-based model. Differences in effectiveness of center- and home-based intervention on language vs. cognitive skills is particularly intriguing in light of more pronounced effects of cocaine on language outcome. It appears that our most intensive intervention affected the specific area of delays for which this group of children is at most risk (Lester, LaGasse, & Seifer, 1998).

For gross motor skills, center-based intervention resulted in a large effect and home-based intervention resulted in a moderate effect compared to the primary care group. A dose-response effect in gross motor skills was hypothesized, because children in the center received daily opportunities to engage in outdoor and indoor play activities, whereas home-based children received such activities only as part of the biweekly intervention.

Both interventions appeared to have similar but small effects on behavior ratings, with center-based intervention resulting in only slightly larger effects. In contrast to the language and cognition measures, this outcome measure is rated by parents rather than by independent experimenters, and it assesses how children behave in interaction with their parents. Because behavior is dependent on the context, particularly in young children, it is not clear what effect, if any, the intervention might have on children's behavior in other contexts such as preschool classrooms.

This study is the first to compare directly center and home programs for this population. Across studies of early intervention with at-risk populations, center-based programs are usually the only programs effective in improving child development directly (Warr-Leeper, 2001). Recent exceptions are studies of Early Head Start programs which demonstrated that fully implemented home-based programs improved cognitive and language outcomes (Administration for Children, Youth, and Families [ACYF], 2002). For children exposed to substances, one home visiting program was successful in improving child behavior (Butz et al., 2001), but no direct effects on children's cognitive development have been demonstrated (Black et al., 1994). Our home visiting program was conceptualized as a less intensive intervention implemented directly with the child rather than an intervention implemented directly with the mother who abused substances (Butz et al., 2001; Schuler et al., 2000).

Home- and center-based programs are qualitatively different interventions. In addition to the direct interactions between teachers and children, the center-based program also changed the child's environment for the duration of services, whereas the home-based program provided an opportunity for the parents to interact with and observe the home visiting teacher. Based on the teachers' feedback, few parents directly participated when teachers worked with the child, but most observed or talked to the teacher at some point during the home visit. Some parents spoke to the teacher on a regular basis about a range of concerns, using the teacher as a confidant. Although they were invited to participate in the classrooms, the parents in the center-based program typically did not attend and had limited interactions with teachers. Thus, center and home-based programs differed in intensity but cannot be viewed as the same intervention in different doses. Ultimately, an optimal program for these infants might need to combine elements of both programs. Indeed, a mixed home- and center-based approach showed the most impact on children and families participating in Early Head Start (ACYF, 2002). Given these data and feedback from our intervention staff, a program could be customized for the individual circumstances of each family, particularly if it can be continuously adapted to changes in family circumstances and custody placements.

### *Limitations*

A major limitation of this study was the lack of a true, randomly assigned, non-intervention control group. The extent to which primary care services such as consistent access to medical and social services alone improved

outcomes is not known. Thus, it is possible that intervention effects were slightly underestimated. Indeed, 11 of the 34 children at age 2 scored so low on their developmental scores (<70) that we referred them to other early intervention programs. According to parent report, nine of these children were receiving intervention by age 3; three children were enrolled in center-based intervention and the others were receiving part-time interventions such as speech therapy. In addition, the fact that the primary care group were born after the intervention groups could bias the results because hospital procedures for testing and reporting drug exposure change over time. Moreover, although drop-outs did not differ significantly from participants on available measures, except for race/ethnicity, bias due to attrition cannot be excluded. It is also not clear whether the outcomes were affected by the fact that, despite random assignment, the center-based group had significantly more unstable home situations.

### *Implications*

These data support the effectiveness of a comprehensive early intervention approach in a population at risk due to prenatal and postnatal factors. The effectiveness of center-based intervention for impacting language outcome is encouraging given the increased risk for language delays in children prenatally exposed to cocaine.

Although unique risks are present in these children's lives that are associated with their mothers' substance use, they are similar to other children at risk (Frank et al., 2001). Thus, results of this study might have implication for other at-risk populations. Additional studies comparing interventions for exposed and non-exposed populations, however, would be needed to clarify this issue. It remains to be seen whether children prenatally exposed to cocaine are best served in programs specifically designed for populations who are substance exposed. In our experience, these children are not inherently different from other children who are at risk. Their family situations, however, including instability, dysfunction, extreme variations in compliance with paper work, custody issues, and needed coordination with social service agencies create a specific pattern of needs that are difficult to address by staff without sufficient experience with these unique issues.

An important factor for the implications of this study will be whether effects of early intervention are maintained over time. The intervention is currently ongoing, thus, this study provides an initial report as part of a long-term, multi-cohort longitudinal study. Long-term data at school entry are needed and will be collected in the next few years. Outcome data on additional cohorts from the ongoing intervention program in future years will allow us to replicate findings and form larger groups with sufficient statistical power for the analysis of covariates. To explicate further the outcome analyses, we have also been conducting qualitative case studies (Dice, Avchen, Claussen, & Scott, 2003). One essential conclusion from our work is that prenatal exposure to cocaine is a marker for a complex set of interrelated risk factors that affect the effectiveness of intervention.

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*The research and intervention project presented in this paper was supported by Grant No. H023C30079 from the Office of Special Education and Rehabilitative Services, Department of Education; Grant No. SPO8984 from the Center for Substance Abuse Prevention, Substance Abuse and Mental Health Services Administration; by funds from Infants In Need, Inc., Florida Diagnostic Learning Resources System, Florida Department of Education; the Miami Dade County Public Schools; the Dade Community Foundation; and from members of the Miami philanthropic community.*

*We would like to express our sincere thanks to the intervention and social work staff, the research team, and the administrative staff members who have put their hearts and efforts into the development of the program and participate in the ongoing day-to-day operations, without whom none of the efforts would be possible. Many thanks also to all the individuals and organizations who support our continuing early intervention project and its multiple components, including Shan Goff and the Florida Department of Education. Bureau of Instructional Support and Community Services, Wendell and Linda Ray, The Department of Children and Families at both the District XI and state level, Ron Felton and Roni Bader-Tables (Miami-Dade County Public Schools Exceptional Student Education Services), the State Department of Transportation, Metro-Dade Transit Disadvantaged Services, the State Department of Health/Child Nutrition Program, the U. S. Department of Justice, Office of Juvenile Justice and Delinquency Prevention, and the Honorable Judges Cindy S. Lederman and Jeri B. Cohen, Eleventh Judicial Circuit, Dependency Division, as well as the local and state Administrative Office of the Courts.*

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