LITERATURE REVIEW:

EFFECTS OF PRENATAL SUBSTANCE EXPOSURE ON INFANT AND EARLY CHILDHOOD OUTCOMES

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Introduction

Substance abuse among pregnant women continues to pose a national concern for a host of reasons, not the least of which is the impact of prenatal substance exposure on their children. Although anecdotal and media reports often described children prenatally exposed to substances as seriously impaired developmentally, recent research suggests that these effects are not as profound as was once believed. A thorough review of current literature reveals that in-utero substance exposure can leave children vulnerable to a number of developmental problems. However, many of these problems are treatable and can be addressed with a variety of interventions. In fact, research suggests that the home environment in which the child is reared may have a stronger influence on developmental outcomes than prenatal drug exposure. In all likelihood, the direct biological effects of prenatal drug exposure and the postnatal effects of being raised by a substance using mother overlap to produce a cumulative effect on children's development.

This document highlights recent findings from academic literature concerning the debate about the consequences of prenatal substance exposure on infants and children. Cocaine exposure has been the primary focus of the large majority of research studies and, thus, is featured prominently in the literature. Research findings from the developmental domains of motor skills, cognition, language skills, school performance, behavior, attachment, and physical growth are presented here. Finally, possible interventions and implications for practice and policy are discussed.

Prevalence of Substance Use during Pregnancy

According to the *2004 National Survey on Drug Use and Health* (NSDUH), 4.6% of pregnant women aged 15 to 44 reported using illicit drugs, 11.2% reported alcohol use[1], and 18% reported using cigarettes in the last month (Substance Abuse and Mental Health Services Administration [SAMHSA], 2005). The total number of pregnant White women using illegal drugs (113,000) has been found to be higher than African Americans and Hispanics (75,000 and 28,000 respectively), although pregnant African American women experience higher relative rates of drug use (NIDA, 2005).

The *NSDUH* also reveals a lower frequency of illicit substance use by pregnant women compared to non-pregnant women in the same age cohort (SAMHSA, 2004b; SAMHSA, 2005). Rates of tobacco and alcohol use are also considerably lower among pregnant women compared to non-pregnant women (SAMHSA, 2004a; SAMHSA, 2005). Given the statistics, pregnancy in itself may be a deterrent to substance use.

Based on estimates from the *National Survey on Drug Use During Pregnancy* (1992), each year approximately 222,000 infants are born to mothers who used illegal drugs during pregnancy (National Institute on Drug Abuse [NIDA], 2005). The number of children affected by prenatal substance exposure, however, is difficult to estimate for multiple reasons, including underreporting of drug use by mothers and the inconsistency of drug testing during labor and delivery (Covington, Nordstrom-Klee, Ager, Sokol, & Delaney-Black, 2002). As a result, the actual number of infants and children prenatally exposed to substances is not precise.

[1] 4.5% and .5% of pregnant women reported binge alcohol use (5 or more drinks on the same occasion on at least 1 day in the past 30 days) and heavy alcohol use (five or more drinks on the same occasion on each of 5 or more days in the past 30 days), respectively.

Research Limitations

Research findings concerning the effects of prenatal substance exposure on children's development are often inconclusive and controversial. It is often difficult to quantify the developmental effects of prenatal exposure to a specific substance. The development of infants exposed prenatally to substances may be simultaneously affected by numerous factors, including exposure to multiple substances and utilization of prenatal care (NIDA, 1998). Specifically, mothers who gave birth to infants prenatally exposed to illegal substances were also found to have used greater amounts of alcohol and tobacco while pregnant compared to mothers whose children were not exposed and were also less likely to have received prenatal care or had fewer prenatal care visits (Delaney-Black, Covington, Nordstrom, Ager, Janisse, Hannigan et al., 2004; Frank, Jacobs, Beeghly, Augustyn, Bellinger, Cabral et al., 2002; Hurt, Brodsky, Roth, Malmud, & Giannetta, 2005; B. A. Lewis, Singer, Short, Minnes, Arendt, Weishampel et al., 2004; Linares, Singer, Kirchner, Short, Min, Hussey et al. 2005; Messinger, Bauer, Das, Seifer, Lester, & Lagasse, 2004; Shankaran, Das, Bauer, Bada, Lester, Wright et al. 2004; Singer, Minnes, Short, Arendt, Farkas, Lewis et al., 2004; Smith, Yonekura, Wallace, Berman, Kuo, & Berkowitz, 2003). Other moderators, such as the type of substance (both licit and illicit), amount of exposure, frequency of use, and timing during pregnancy, may also affect child outcomes (Carta, Atwater, Greenwood, McConnell, McEvoy, & Williams, 2001; Covington et al., 2002; Singer et al., 2004).

Some researchers take issue with the study methods and substance measurement techniques employed in recent studies. For instance, small sample size, high attrition rates, and lack of longitudinal studies may contribute to the scarcity of definitive findings for this population (Covington et al., 2002; Singer, Arendt, Minnes, Farkas, Salvator, Kirchner et al., 2002). Inconsistent research findings may also be due to variations in the methods for measuring substance use (Carta et al., 2001).

Furthermore, most current academic research has sampled predominantly African American women from low socioeconomic backgrounds at urban hospitals (Accornero, Morrow, Bandstra, Johnson, & Anthony, 2002; Arendt, Short, Singer, Minnes, Hewitt, Flynn et al., 2004; Bandstra, Morrow, Vogel, Fifer, Ofir, Dausa et al., 2002; Covington et al., 2002; Delaney-Black et al., 2004; Hurt et al., 2005; B. A. Lewis et al., 2004; Linares et al., 2005; Messinger et al., 2004; Morrow, Vogel, Anthony, Ofir, Dausa, & Bandstra, 2004; Schroder, Snyder, Sielski, & Mayes, 2004; Schuler, Nair, & Kettinger, 2003; Seifer, LaGasse, Lester, Bauer, Shankaran, Bada et al., 2004; Shankaran et al., 2004; Singer et al., 2002; Singer et al., 2004). Consequently, pregnant women from other racial, ethnic, and socioeconomic backgrounds are not proportionately represented in research findings and, therefore, research results may not be generalizable to other populations.

Perhaps the most important limitation of the current research is the complexity and difficulty presented in attempting to tease out the specific developmental effects of drug exposure from the effects of the child's home environment. How and by whom the child exposed to substances in-utero is raised can have profound effects on growth and development. For example, Covington et al. (2002) suggest that socioeconomic factors associated with maternal drug use, such as low maternal educational attainment, insufficient prenatal care, and premature delivery, more directly affect developmental outcomes for substance-exposed children. In addition, maternal substance use often leads to insensitivity when interacting with children, difficulty monitoring older children, child maltreatment, and primary caregiver instability, which can

all negatively affect child development (Hans, 2002). The home environment for children prenatally exposed to drugs appears to be critical and must be considered before forming a definitive conclusion about in-utero drug effects alone. The sum combination of biological effects of prenatal drug exposure and postnatal home environment characteristics appears to influence child development. An examination of the different developmental domains will explore the impact of these factors.

Child Growth and Development

Motor Development

Motor development is one significant domain to consider in examining the effects of prenatal drug exposure on infants and children. Motor skills are critical for school activities, including writing, and may affect future academic achievement. Deficiencies in such skills may cause frustrations while playing with toys or engaging in other activities, such as drawing or painting (Monterey County Screening Team for Assessment, Referral, and Treatment (MCSTART), 2004). Furthermore, attention deficit, hyperactivity, or learning disorders may be related to motor difficulties and may become noticeable as the child ages (Arendt, Angelopoulos, Salvator, & Singer, 1999).

Frank, Augustyn, Knight, Pell, and Zuckerman (2001) systematically reviewed the research prior to 2001 on the effects of prenatal cocaine exposure, and their meta-analysis suggests that prenatal exposure to tobacco is related to poor early motor development, but no effect related to cocaine exposure was identified. Singer et al. (2002) similarly found an association with tobacco exposure and poor motor development, but not with cocaine exposure.

A 3-year longitudinal study of cocaine and opiate-exposed infants by Messinger et al. (2004) again revealed that motor development was not affected by cocaine exposure, but lower performance was predicted by exposure to opiates. Controlling for covariates, however, factors such as poor caregiving environment, low maternal vocabulary scores and low infant birth weight were found to be stronger predictors of deficient motor performance than opiate exposure (Messinger et al., 2004).

While these studies demonstrated the lack of a significant effect of cocaine on motor development, other researchers differed in their conclusions. Specific to cocaine exposure, the results of a recent study predicted poorer motor development at ages 1 through 3 years, even after controlling for prenatal exposure to tobacco (M. W. Lewis, Misra, Johnson, & Rosen, 2004). Poor motor performance has additionally been found to be associated with heavy cocaine use (Miller-Loncar, Lester, Seifer, Lagasse, Bauer, Shankaran et al., 2005). A separate study likewise found an association between the amount of cocaine exposure and deficits in motor skills at age 7 (Arendt et al., 2004).

Research among infants from high-risk environments characterized by poverty and instability revealed that children exposed prenatally to cocaine showed a decline in motor performance through age 3 compared to unexposed children. Similar, though less pronounced, deficits in motor development were also found among unexposed and other drug exposed groups (i.e., alcohol, tobacco, marijuana) from similarly disadvantaged backgrounds (Mayes, Cicchetti, Acharyya, & Zhang 2003).

Cognitive Development

The domain of cognitive development for infants and children deserves careful investigation, as disruption or delays in cognition during infancy may predict learning difficulties as the child progresses to school age (Singer et al., 2002). A review of current research reveals a significant discrepancy regarding the effect of cocaine on cognition.

Findings from Frank et al.'s (2001) meta-analysis of past research concluded that delays in cognitive development were significantly related to environmental factors, and that exposure to cocaine had no significant impact. Such environmental factors included: the type of caregiver (e.g., biological mothers compared to kinship caregivers or foster parents), the provision of case management or home visiting services for the caregiver, the quality of the home environment, and the maternal IQ score. History of prematurity, age at assessment, and effects of exposure to other substances prenatally were additional predictors of cognitive development (Frank et al., 2001). Other research studies have also shown no significant differences in cognitive performance between children up to 4 years of age who were and were not exposed to cocaine prenatally (Brown, Bakeman, Coles, Platzman, & Lynch, 2004; Messinger et al., 2004; Singer et al., 2004).

However, some recent research has concluded that cocaine does have a direct impact on early cognitive development. For example, one study reported an association between abnormal neurological exams and cocaine exposure at birth through 3 years of age (M. W. Lewis et al., 2004). In addition, a 2004 study concluded that prenatal cocaine exposure yields prolonged effects into childhood. A study of 7-year old children who were prenatally exposed to cocaine found significantly lower IQ scores among this group than non-exposed children (Arendt et al., 2004). Furthermore, at 8 and 9 years of age, children with exposure to cocaine had deficits in visuospatial memory and demonstrated slower visuomotor speed compared to peers who had not been exposed in-utero (Schroder et al., 2004).

Another recent, large-scale, longitudinal investigation of a cohort of drug abusing mothers and their children, at two points in time, found significant effects of cocaine exposure on cognitive deficits at 2 years of age, but no such association at 4-years old (Singer et al., 2002; Singer et al., 2004). Researchers concluded that while drug exposure may be associated with poor cognitive outcomes initially, substance effects may wane over time and be outweighed by factors in the child's environment.

According to Singer et al. (2004), the quality of the caregiving environment (as assessed by the Home Observation of the Environment (HOME) scale) was found to be the strongest predictor of cognitive performance among 4-year old cocaine-exposed children. Exposed children placed in (non-relative) foster care or adoptive care had outcomes similar to non-exposed children who lived with biological mothers in less stimulating and lower socioeconomic backgrounds (Singer et al., 2004). A separate study found that, at 2 years of age, cocaine-exposed children residing in non-parental care had more optimal home environments and better cognitive, social, and emotional outcomes compared to exposed children who remained in the care of their parents (Brown et al., 2004).

Maternal characteristics may also be associated with cognitive outcomes for substance-exposed children. For example, greater maternal psychological distress was found to be associated with lower knowledge acquisition for children prenatally exposed to cocaine (Singer et al., 2004). Further research demonstrates that biological mothers' vocabulary is a stronger predictor of children's mental development than cocaine exposure (Arendt et al., 2004; Messinger et al., 2004). Such a finding is significant, given that mothers of cocaine-exposed children have been found to have lower vocabulary scores than non-using mothers (Arendt et al., 2004).

Language Skills

Another domain thought to be affected by substance exposure is language skills and development. Recent research suggests that, in examining language skills among

children, the effects of drug exposure, home environment, and maternal characteristics appear to be overlapping and intertwined.

As with the other domains discussed above, Frank et al.'s (2001) meta-analysis of research prior to 2001 found that language scores among toddlers were not associated with prenatal exposure to cocaine. However, more recent research has found associations between cocaine exposure and depressed language functioning in children from 3 to 7 years of age (Bandstra et al., 2002; B. A. Lewis et al., 2004; Morrow et al., 2004). Furthermore, while impoverished African American children, in general, may be at risk for language deficiencies, findings show that those who have been prenatally exposed to cocaine appear to be at increased risk for deficits in speaking ability compared to non-exposed African American children from similar socioeconomic backgrounds (Morrow et al., 2004).

A study by Bandstra, Vogel, Morrow, Xue, and Anthony (2004) suggests a relationship between prenatal cocaine exposure and language functioning among cocaine-exposed children at 4 ½ years of age. More specifically, greater severity of prenatal cocaine exposure, as measured by mothers' self-report and drug testing, was found to be independently associated with greater deficits in language performance. This study suggests that the developmental consequences of prenatal exposure to cocaine may be influenced by the severity of exposure.

Substances other than cocaine, such as alcohol, tobacco, and marijuana, also have been found to have an effect on language development. Prenatal exposure to tobacco and marijuana has been found to predict deficits in language (B. A. Lewis et al., 2004), and decreased language performance has also been associated with the level of prenatal alcohol exposure (Bandstra et al., 2002).

However, research findings also demonstrate a correlation between child language abilities and specific maternal characteristics, such as IQ, race, education, and language ability (B. A. Lewis et al., 2004). Prenatally exposed children residing in out-of-home care were also found to have higher language skills compared to those living with a relative or biological mother (B. A. Lewis et al., 2004). Furthermore, at 4 years of age, exposed children in foster or adoptive homes performed at the same level as children who had not been exposed (B. A. Lewis et al., 2004). The researchers posit that the positive effects of a more stimulating environment, including higher verbal IQ scores of foster and adoptive mothers, contribute to improved language performance (B. A. Lewis et al., 2004).

Behavior

Frank et al.'s (2001) meta-analysis of studies of children prenatally exposed to cocaine revealed decreased emotional expressiveness among exposed children, but no behavior disturbances. A more recent review of the literature finds a gender difference in behavioral outcomes and inconsistent results with respect to outcomes for girls. Delaney-Black et al. (2004) found no significant differences in behavioral problems between cocaine-exposed and non-exposed girls at 6 years of age. Other studies, however, reveal that girls prenatally exposed to cocaine demonstrated increased aggression compared to girls who did not have cocaine exposure (Nordstrom Bailey, Sood, Sokol, Ager, Janisse, Hannigan et al. 2005; Sood, Nordstrom Bailey, Covington, Sokol, Ager, Janisse et al., 2005).

Among boys, cocaine exposure has been found to be associated with a higher rate of hyperactivity, problem behaviors, and externalizing behaviors (Delaney-Black et al., 2004; Nordstrom Bailey et al., 2005). Boys, 6-7 years of age dually exposed to alcohol and cocaine, demonstrated more frequent delinquent behavior compared to boys exposed prenatally to alcohol but not to cocaine (Nordstrom Bailey

et al., 2005). Additionally, a study of children's behavior at 6 years of age found that teachers reported more behavioral problems, more problems with motor skills, and greater passivity to the environment among cocaine-exposed boys compared to boys who were not exposed (Delaney-Black et al., 2004).

In addition to gender differences, drug-exposed children's placement location also has been associated with prevalence of disruptive behaviors. According to one study, foster and adoptive caregivers rated cocaine-exposed children as having more externalizing behaviors than similarly exposed children living with a relative or biological mother (Linares et al., 2005). Furthermore, using the Dominic Interactive (DI), a child self-report measure, 6-year old cocaine-exposed children living in a foster or adoptive care arrangement reported more externalizing symptoms than same-aged exposed children in biological or relative care and children without prenatal exposure (Linares et al., 2005).

Possible reasons for discrepancies based on placement are mixed, and research has not specifically examined individual factors. Linares et al. (2005), however, suggest the following reasons for greater reporting among foster and adoptive parents: cocaine-exposed children in foster or adoptive care may actually have more behavioral problems compared to non-exposed children and exposed children in maternal or relative care; adoptive or foster parents may be more sensitive to behavioral problems and difficulties with adjustment; children in out-of-home, non-relative care may be referred to and thus utilize more mental health programs, bringing to light problems with behavior; or simply removing the child from maternal care may result in adjustment difficulties resulting from the loss of familiar attachment figures. Looking specifically at adoptive or foster homes, other reasons for disparities may include that such placements have greater structure and rules; these caregivers may have higher behavioral standards than biological parents; and adoptive or foster caregivers may have a biased opinion of cocaine-exposed children and may expect poor behavioral outcomes (Linares et al., 2005).

As in other developmental spheres, the specific effects of drug exposure on behavioral outcomes are difficult to measure. In one comparison of inner-city children, with and without prenatal drug exposure, teachers did not distinguish any difference in behavioral problems such as attention or impulse control (Savage, Brodsky, Malmud, Giannetta, & Hurt, 2005). Such findings are consistent with a study by Accornero et al. (2002), which also found a lack of association between prenatal exposure and behavior reports. Behavioral problems may, in fact, be related to factors such as recent maternal illicit drug use, maternal psychological functioning, low maternal vocabulary scores, and low infant birth weight rather than the exclusive effects of in-utero drug exposure (Accornero et al., 2002; Messinger et al., 2004).

Attachment

The effects of prenatal substance exposure have also been studied in relation to differences in attachment patterns. Attachment refers to a child's interaction with the primary caregiver and the sense of security the caregiver imparts to the child. Infant attachment behavior largely establishes the basis for the child's emotional and social development, as well as future relationships with family, friends, and peers. For this reason, attachment often is considered a cornerstone of healthy child development (U.S. Department of Health and Human Services, 1991).

Research has documented a relationship between prenatal alcohol exposure and insecure attachments between infant and mother (O'Connor, Kogan, & Findlay, 2002). However, information on the effects on attachment

patterns from prenatal exposure to illicit drugs is limited. According to one study, children exposed to cocaine and opiates were found to have lower rates of attachment at 18 months compared to non-exposed children. However, these attachment patterns were also found to be mediated by the temperament of the child, behavioral problems, and self-esteem of the caregiver (Seifer et al., 2004).

Although Seifer et al.'s (2004) study documents an effect of cocaine exposure on infant-caregiver attachment, other research demonstrates that the dosage and level of exposure to cocaine do not influence attachment patterns. Research by Beeghly, Frank, Rose-Jacobs, Cabral, and Tronick (2003) suggests that the level of prenatal cocaine exposure was not significantly related to attachment status at 12 months of age. They did note, though, that infants with greater exposure to cocaine prenatally demonstrated less crying upon separation from their caregivers compared to unexposed infants (Beeghly et al., 2003).

School Performance

Given the emphasis on education in predicting future outcomes for children, examining the effects of substance exposure on academic performance is particularly significant. Based on a review of the current literature, several studies reveal no difference in school achievement between children who were prenatally exposed to cocaine and those who were not (Frank, Rose-Jacobs, Beeghly, Wilbur, Bellinger, & Cabral, 2005; Hurt et al., 2005; Pulsifer, Radonovich, Belcher, & Butz, 2004). In particular, a study of inner-city children from kindergarten through 4th grade found that both cocaine-exposed and non-exposed children performed equally poor in academics -- both groups had low grade point averages, were reading below grade level, and scored below average on standardized tests -- and no significant differences were identified between the groups (Hurt et al., 2005). Another study also demonstrated that among 4 and 5-year olds with and without illicit drug exposure, matched along demographic characteristics, no significant difference in intelligence was identified (Pulsifer et al., 2004). The prevalence of academic risks among both children with drug exposure and those without exposure highlights the need to address educational concerns among youth sharing common demographic markers.

Regardless of prenatal cocaine exposure, children in the 4th grade with more cognitively stimulating home environments were found to have more successful grade promotion and higher IQ scores compared to those whose environments were less favorable (Hurt et al., 2005). Moreover, caregivers of exposed children have demonstrated significantly lower scores in intelligence and reading achievement than caregivers of non-exposed children, and caregiver reading test scores were found to associate with children's intelligence (Pulsifer et al., 2004). Higher education levels among birth mothers also have been found to be associated with higher IQ scores among prenatally exposed children (Frank et al., 2005). As children presented in research findings on substance exposure hail from similarly disadvantaged urban backgrounds as other low-performing children, academic differences appear to be less a function of drug exposure than of their environment.

Physical Growth

Infant physical growth is considered significant given that "small for gestational age," or low birth weight, is associated with developmental delays and abnormal metabolic processes (MedlinePlus, 2005). Specifically, deficits in physical growth have been found to be related to delays in motor development, decreased physical activity, cognitive deficits, increased blood pressure, low blood sugar, low body temperature, and obesity (Covington et al., 2002; MedlinePlus, 2005). A review by Covington et al. (2002) additionally reveals that birth size and growth have been related to poor social outcomes for children.

Prenatal substance exposure among infants generally has been associated with greater risks of premature delivery and deficits in physical growth, including low birth weight, small head size, and short birth length as compared to unexposed infants. However, the effects of exposure to a single substance are difficult to distinguish. For example, Frank et al.'s (2001) systematic review of research prior to 2001 found no specific negative effects of cocaine on child weight, length, or head circumference.

More recent studies, however, have concluded that in-utero cocaine exposures can affect physical growth. For example, Mayes et al. (2003) concluded that infants born exposed to cocaine had significantly lower birth weights and smaller head sizes compared to non-exposed infants or those exposed only to alcohol, tobacco, or marijuana. Likewise, a study by Shankaran et al. (2004) found differences along domains of growth for infants who were and were not exposed to cocaine prenatally, with greater growth among those who were not exposed. Persistent, low cocaine use during pregnancy was also found to result in significantly lower birth weight among exposed infants than infants of non-users, and infants whose mothers used moderate amounts of cocaine consistently had significantly smaller head circumference (Shankaran et al., 2004). Taking an extended look, additional research has not only demonstrated an association between prenatal cocaine exposure and height and weight deficits at birth, but also height deficits at 7 years old (Covington et al., 2002).

Research also shows evidence of an association between fetal growth and birth weight and prenatal exposure to tobacco, alcohol, methamphetamines, and marijuana. Infants whose mothers smoked tobacco during pregnancy were found to have lower birth weight, shorter length, and smaller head circumference than those who were not directly exposed to nicotine (Covington et al., 2002; Shankaran et al., 2004; Smith et al., 2003). In fact, infants born to mothers who used any alcohol or tobacco had significantly lower birth weight, shorter birth length, and smaller head circumference than those infants who were born to mothers who did not use any drugs (Shankaran et al., 2004).

In addition, the amount and frequency of marijuana use during pregnancy has been shown to have negative effects on fetal growth (Hurd, 2005). Recent research has also shown that methamphetamine-exposed newborns, who were also exposed to nicotine, had significantly lower birth weights and significantly smaller head circumferences than infants exposed to methamphetamine alone (Smith et al., 2003).

Intervention Strategies

Though the conclusions of the specific effects of prenatal substance exposure on developmental outcomes are complex and, at times, contradictory, the challenges and risks faced by substance-exposed newborns are evident and deserving of attention. Consequently, interventions should be targeted to overcome barriers that inhibit healthy development for both child and mother.

Overarching Programmatic Recommendations

The federal government has devoted considerable funding and demonstrated impressive leadership in the response to families who are impacted by substance abuse. Within the Department of Health and Human Services, both the Center for Substance Abuse Treatment (CSAT), under the Substance Abuse and Mental Health Services Administration (SAMHSA), and the Children's Bureau, under the Administration for Children and Families, have sponsored demonstration programs for over a decade to address this problem.

The Treatment Improvement Protocol (TIP) on substance-exposed newborns, established by CSAT/SAMHSA, identifies five key programmatic considerations when working with these families: (1) cultural and racial concerns must be considered in every aspect of the treatment process for drug-exposed infants and their families; (2) fathers should be included in treatment to the fullest extent feasible…treatment should be family centered; (3) lack of financial resources limits the ability of many communities to implement all the guidelines…community coordination and collaboration can help bridge the gap in resources; (4) interdisciplinary training is essential in effectively serving drug-exposed infants and their families; and (5) problems of drug-exposed infants are present in communities throughout the United States, cutting across all income levels (Kandall, 1993).

CSAT/SAMSHA also suggests that services should demonstrate cultural competence, use outreach workers and community-based organizations, coordinate with other agencies, and implement non-traditional approaches such as home-based services (Kandall, 1993). Service providers are advised to be cognizant of the various environmental factors that may contribute to a cumulative effect along with substance exposure. Risk factors include poverty, poor nutrition, lack of health insurance, poor parenting skills, and child abuse or neglect (Kandall, 1993). Finally, recommendations are made that a comprehensive model for health and psychosocial services focus treatment on both the drug-exposed infant and the drug-abusing mother. Consequently, such a model should include components embracing health, mental health, and social services, as well as educational, vocational, and employment programs (Kandall, 1993).

Since 1990, the Children's Bureau has provided grant funding, under the Abandoned Infants Assistance (AIA) program, to support demonstration service programs working with families affected by substance abuse. In reflecting on the lessons learned in over a decade of direct service, AIA administrators developed a set of recommendations and guidelines in their monograph, *AIA Best Practices: Lessons Learned from a Decade of Service to Children and Families Affected by HIV and Substance Abuse* (National AIA Resource Center, 2003). An underlying principle emphasized by AIA administrators is the importance of developing a strong relationship, and building trust and respect between project staff and the family. The authors suggest focusing interventions on families as a whole and utilizing the strengths of the family to promote healthy development for children (National AIA Resource Center, 2003). In addition, the authors recommend home-based, nonjudgmental intervention strategies that are barrier free and flexible. Moreover, successful outcomes are also predicted by careful risk assessments of infants and children and collaboration between agencies and disciplines (National AIA Resource Center, 2003).

Successful Service Interventions for Healthy Family Development

Direct services and interventions recommended by AIA projects include: comprehensive assessments to assess strengths and resources, care coordination and case management, developmental monitoring for children, parenting and family support, work with fathers and relative caregivers, and empowerment of parents to consider voluntary relinquishment of children as a permanency option (National AIA Resource Center, 2003). A cross-site evaluation of AIA projects targeting substance affected children and families reveals improvements in the safety and well-being of participating children. Among the gains noted are reduction in hospital stays, improved parent-child interactions, favorable child development outcomes, and

greater maternal health, including prenatal care utilization (Brown, Fuger, Todd, Stephens, & Reeves, 2005).

One successful AIA program, the Coordinated Intervention for Women and Children (CIWI) project, provides clinical and support services for substance abusing mothers and their families both in the home and in partnership with Yale New Haven Hospital. Enrollment in this program has been found to yield similar lengths of hospital stays for infants with prenatal cocaine exposure and those without (National AIA Resource Center, 2003).

A second successful AIA project, the Team for Infants Endangered by Substance abuse (TIES), provides multiple services including counseling and support, parenting education, and links with community resources, including drug treatment programs and primary health care. Substance using mothers enrolled in this program demonstrated positive outcomes: a higher percentage of program participants enrolled in drug treatment and demonstrated improvement in their interactions with their infants in comparison to a group of mothers not enrolled in the program (National AIA Resource Center, 2003). Participation in the TIES project also resulted in higher developmental scores for infants prenatally exposed to drugs.

While both of these programs have positively impacted women, the most successful projects were those that targeted mothers during pregnancy. One such program, Project Prevent, provided comprehensive services to pregnant women, along with women whose infants were admitted to the intensive care nursery upon birth, through use of home visits, outreach, teaching and multi-agency collaboration. Following participation in this program, these infants had higher birth weights and lower positive toxicology screens at birth. Additionally, these mothers had twice as many prenatal care visits as mothers who had enrolled in the program following birth of their children (National AIA Resource Center, 2003).

The most recent cross-site evaluation of AIA programs further revealed that infants of those mothers who received prenatal services were found to have improved infant outcomes, including higher birth weight and decreased number of days of hospitalization at birth, compared to infants whose mothers enrolled after delivery (Brown et al., 2005). Substance abusing women have likewise benefited from participation in AIA projects. Overall, 28% of mothers who received services from an AIA project were using substances at the time of termination, which is a significant decrease from the 45% who were known to be using at the time of intake (Brown et al., 2005).

Looking beyond AIA projects, researchers have examined the effectiveness of three other intervention programs designed to improve the well-being of parents and children affected by illicit drugs: Project Support, Trust, Rehabilitation, Initiative, Values, and Education (STRIVE); the Early Infant Transition Center; and Home-U-Go Safely (HUGS) (Belcher, Butz, Wallace, Hoon, Reinhardt, Reeves et al., 2005). These programs were supported through both federal and private funds and ranged from pregnancy to early childhood, were community-based, culturally relevant, and targeted both children and their caregivers. In Tampa, Florida, Project STRIVE was designed to provide substance abuse treatment, social work services both in the community and at home, parent education, and obstetric and pediatric medical care. Services for mothers and infants were integrated and provided in a community-based teaching clinic. Findings revealed significant positive outcomes for infants at birth, including higher weight, longer length, and larger head circumference compared to infants whose mothers were not enrolled in this program.

Similarly, parents reported increased knowledge of parenting, decreased use of corporal punishment, and reduced depression following completion of the program.

Participation in the Kennedy Krieger Institute's Early Infant Transition Center (EITC), in East Baltimore, Maryland, likewise demonstrated benefits for mothers and infants affected by substance abuse. The EITC, a community-based medical center, provided medical services for infants with neonatal abstinence syndrome, as well as social services for parents. Social services included counseling, parent education, substance abuse treatment, and community referrals. At discharge from the center, infants showed significant improvements in weight and head circumference (Belcher et al., 2005).

Mothers who completed the HUGS program, a home-based nursing program in Baltimore, Maryland, also reported significantly fewer internalizing and externalizing behaviors among infants in comparison to children who did not complete the intervention program. Through this program, nurses monitored the infant's health and growth, provided support and developmental guidance to mothers and caregivers, and promoted physical contact between the mother and the child through teaching the use of a Snugli, a front-worn carrier for the child. While these intervention strategies are by no means all-inclusive, future programs should consider the wide range of factors that should be addressed among this population (Belcher et al., 2005).

Other examples of types of intervention strategies for toddlers include the following: early childhood programs (e.g., Head Start); individual therapy; support of self-regulation; and supporting relationships with care providers (Kandall, 1993). Children's participation in preschool enrichment programs also may enhance academic achievement among those exposed prenatally to cocaine, as research has demonstrated an association between attendance at such programs and higher IQ scores (Frank et al., 2005).

Finally, early intervention in particular appears to have protective effects on children's cognitive development, primarily among infants with heavy cocaine exposure receiving services within the first year of life (Frank et al., 2002; National AIA Resource Center, 2003). A study of a home visiting intervention for both children and substance using mothers found that children participating in the program had higher scores on mental and motor developmental measures compared to a control group of exposed children not receiving the service (Nair et al., 2003). In another study, an examination of 18-month old infants whose mothers participated in a home intervention program revealed slightly better developmental scores compared to a control group, and the greatest positive effects were noted when mothers were not currently using cocaine and/or heroin (Schuler, Nair, & Kettinger, 2003). With respect to language development, early detection of deficits may be important in improving long-term outcomes for children (Bandstra et al., 2002); specifically, researchers from the Miami Prenatal Cocaine Study suggest targeting interventions for preschool and school-aged children at improving academic performance and social skills to aid in promoting successful outcomes (Bandstra et al., 2002).

Conclusion

Current research findings demonstrate that the specific physiological effects of prenatal substance exposure on children are inconclusive, thereby necessitating further studies to address substance abuse among pregnant women and the long-term outcomes of their exposed children. Examination of the effects of illicit drugs on physical growth, motor skills, cognition, language skills, school performance, behavior, and attachment reveal contrary

findings; some research finds a drug-related effect while other studies claim a greater environmental effect on outcomes.

The biological effects of drugs, as well as the environmental contexts that may aggravate child outcomes, overlap and result in discrepancies in research findings and difficulties in distinguishing between multiple contributing factors. Important to note, however, is that both children with and without prenatal exposure to substances from equally disadvantaged backgrounds have demonstrated overall poor developmental outcomes. Regardless of whether or not biological effects were found due to the cocaine exposure, all studies noted an environmental impact. This suggests the need to routinely and aggressively address the host of environmental issues that affect families, including poverty, health, education, literacy, and employment, in addition to ongoing substance use.

Additional studies should investigate broader populations, as the research has primarily sampled low-income, ethnic minority women and children. As a result, the current findings are only generalizable to members of these same populations. Only one study reviewed (Smith et al., 2003) included a more balanced sample, including more White and Hispanic respondents than African Americans. The overrepresentation of African American women and children in research on prenatal substance exposure is reflective of the clinic settings in which these studies were conducted. Future research should consider examination of clinic populations in non-urban (e.g., suburban) locations to introduce greater ethnic and socioeconomic variation to the research findings. Furthermore, most research regarding substance exposure in children has focused on the effects of cocaine. With growing use of other substances, such as methamphetamines, additional research should focus on the developmental effects of exposure to all other drugs of choice.

A better understanding of the effects of substance exposure on infants will also drive policies for substance abusing pregnant women (Figdor & Kaeser, 1998; Lester, Andreozzi, & Appiah, 2004). Policies, developed within a social context, must consider both biological effects of substance exposure, as well as environmental risks (Lester et al., 2004). Framing of the problem of prenatal substance exposure is critical in policy development, particularly as there is no consistent approach in viewing this issue. One recommended approach is through a three-tiered prevention model implementing primary, secondary, and tertiary prevention techniques for both illicit and legal drugs. Prevention would thus target substance abuse during pregnancy, identify pregnant substance users, aim to minimize use of drugs during pregnancy, and lessen the consequences of children exposed to drugs (Lester et al., 2004). Among other categories for policy development, Lester et al. (2004) recommend focusing on preventive efforts such as early intervention and education regarding substance abuse. Moreover, policies that support early intervention services for drug-exposed children appear to be beneficial, given the proven record of accomplishment for such programs in aiding development (Frank et al., 2002; Nair et al., 2003; National AIA Resource Center, 2003; Schuler et al., 2003). With such policies in place, better connections can be formulated between knowledge of the effects of substance exposure and treatment and prevention strategies.

The contributions of environment and specific drugs on child development appear interrelated and challenging to tease apart, and a more thorough understanding of the cumulative effects will assist in targeting appropriate interventions for affected women and infants. A continued

comprehensive approach to investigating the outcomes for children with prenatal substance exposure will enhance the existing knowledge base with respect to best practices in addressing the needs of this vulnerable population.

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