PERSISTENT DEVELOPMENTAL DELAYS IN CHILDREN BORN WITH NEONATAL ABSTINENCE SYNDROME AND IN UTERO DRUG EXPOSURE

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PERSISTENT DEVELOPMENTAL DELAYS IN CHILDREN BORN WITH

NEONATAL ABSTINENCE SYNDROME AND

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ABSTRACT

PERSISTENT DEVELOPMENTAL DELAYS IN CHILDREN BORN WITH NEONATAL ABSTINENCE SYNDROME AND IN UTERO DRUG EXPOSURE

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Children born with Neonatal Abstinence Syndrome (NAS) and In Utero Drug Exposure (IUDE) may experience delays that can impact cognition, motor skills, speech and language, attention and behavior development. Furthermore, children born with NAS are more likely to be referred for evaluation and subsequently qualify for special education when compared with non-exposed peers. This quantitative study involved an evaluation of existing visual motor and receptive/expressive language data from birth to 24 months for 106 children born with NAS and IUDE. Results indicated that these children had significant deficits in visual motor scores and receptive and expressive language scores. Significant differences in visual motor and language scores were found between the NAS & IUDE and IUDE only groups. Children in the IUDE only groups had lower scores on visual motor and language assessments; the IUDE only group demonstrated a significant positive rate of change.

For my husband, for his love and support beyond measure.

For my children, for inspiring me to become more.

For the children of the epidemic, we are here for you.

“We can’t forget. Must not forget. That they are all our children, too.”

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CHAPTER I

INTRODUCTION

During the early 2000s, the rise of prescription opioids began to impact communities nationwide. Increases in the availability of prescribed opiates correlated to increases in rates of abuse and addiction of illicit opioids (McHugh, Nielsen, &Weiss, 2015). By 2010, many individuals were battling addiction to heroin. Beginning in 2013, overdose deaths were commonly attributed to synthetic opioids such as fentanyl (CDC, 2018). The use of opioids in pregnant women has led to a new generation of children affected by in-utero exposure who may face impairment in their development as a result.

The National Institute on Drug Abuse (n.d.) defines opioids as a class of drugs that are chemically related and activate opioid receptors within the brain. In addition to providing temporary pain relief, opioids also increase an individual's sense of euphoria. This can lead to misuse of opiates which can create an unwanted addiction. Opioid addiction can arise from prescribed medication but can also be commonly found within street drugs available such as heroin and fentanyl. Estimates indicate that nearly 80 percent of all heroin users began their opioid addiction by using prescription opioids (Jones, 2013).

Throughout this epidemic, dramatic increases in the babies born with Neonatal Abstinence Syndrome (NAS) were also witnessed in communities grappling with drug abuse (Honein, Boyle, & Redfield, 2019). While the immediate, postnatal effects of being born addicted to opiates are easily seen and mimic withdrawal symptoms, scientific research is increasing regarding the long-term effects of In Utero Drug Exposure (IUDE).

A diagnosis of In Utero Drug Exposure is given to an infant when maternal and/or infant blood tests at birth indicate the presence of substances such as cocaine, amphetamines, benzodiazepines, marijuana, barbiturates, and opioids. A diagnosis of Neonatal Abstinence Syndrome is given to infants who demonstrate withdrawal symptoms related to significant in utero exposure to drugs, most commonly opiates. Symptoms of NAS are present at birth and typically last 48-72 hours postnatal (Jones & Fielder, 2015). Symptoms can include tremors, seizures, increased muscle tone, respiratory distress, fever, sweating, gastrointestinal problems, and high-pitched crying. Infants born with NAS are often difficult to console (Harder & Murphy, 2019). It is possible for an infant to be diagnosed with NAS and IUDE at birth.

The prevalence of babies born with NAS increased 300% from 2008 to 2013 (Oei, 2018). Trends in opiate use continued to steadily incline through 2017. In the greater Dayton, Ohio area, the number of pregnant women who struggle with addiction to opiates is an estimated five times higher than national averages (Miami Valley Foundation, 2019). This primed Dayton to become an area of high need for serving babies born with NAS.

Numerous long-term effects have been associated with NAS. Scores on cognitive assessments are often lower for children born with NAS (Yeoh et al., 2019). NAS has also been associated with long-term language, motor, and visual deficits (Merhar et al., 2018). Concerns for attentiveness and behavior have been identified in school-aged children born with NAS (Sandtorv et al., 2018). Indications of significant developmental, cognitive, and motor delays for children born with NAS have been linked with lower overall, long-term academic performance (Oei et al., 2017). Children born with NAS are significantly more likely to be referred for an evaluation and subsequently qualify for special education (Fill et al., 2018). The continued need for support has significant implications for educational teams serving students born with NAS.

Dayton Children's Hospital has increased the long-term follow-up and assessment provided to children born with NAS. However, overall data to identify trends was unclear. The purpose of this project was to examine the relationship between the variables that are associated with persistent developmental delays in children born with NAS and IUDE in the Dayton, Ohio area from birth to two years of age.

CHAPTER II

LITERATURE REVIEW

This literature review begins with an examination of the prevalence and nature of NAS. The sections to follow assess the long-term effects associated with in utero drug exposure, particularly to opiates. Next, potential gaps in services for children with NAS are discussed. Finally, trends and services for children with NAS in the greater Dayton, Ohio area are identified.

Prevalence and Nature of NAS

The exploration of the prevalence and nature of NAS will encompass a review of the trends in opioid use. The nature of NAS will be reviewed by highlighting initial effects of NAS at birth as well as the biological basis of in-utero drug exposure.

Trends in opioid use. According to the Centers for Disease Control (CDC) and Prevention (2018), health care providers wrote 72.4 opioid prescriptions per 100 persons in 2006. The following three years witnessed a steady increase of an estimated 3.0% to reach a pinnacle of opioids prescribed in 2012. From there, health care providers began to reduce the number of opioid prescriptions written. The Centers for Disease Control and Prevention (2018) estimated an overall decrease in the number of opioids prescribed from 2006 to 2017 of 19.6%. This still translated to 58.5 opioid prescriptions per 100 persons in 2017. Most recent estimates from the Centers for Disease Control and Prevention (2019) indicated that the trend in opiate prescriptions continued to decrease in 2018 to 51.4 opioid prescriptions per 100 persons.

The Centers for Disease Control and Prevention (2019) estimated that 67.8% of the overdose fatalities in 2017 involved opioids. Of these opioid-related deaths, the most commonly involved substances were synthetic opiates other than methadone. These substances accounted for approximately 37% of the opioid-related drug overdoses in 2016 and included illicitly manufactured opiates such as fentanyl. Prescription opioids including methadone were involved in an estimated 33% of opioid-related deaths; heroin attributed to 30%. Trend data from the Centers for Disease Control and Prevention (2018) indicated that deaths from opioid overdose continued to increase in 2017. Although the rate of prescribing opioids declined 19.6% overall from 2006 to 2017, it is estimated that opioid overdoses increased six-fold from 1999 to 2017 with steady rates of incline. Nonfatal overdose hospitalizations and emergency department visits significantly decreased in Ohio from 2017 to 2018 (Centers for Disease Control and Prevention, 2019). The Ohio Revised Code 4729.44 (2019) introduced in 2015 made it legal for pharmacies to dispense naloxone, an opioid antagonist used to reverse overdose, without a prescription. This statute along with improved community access to mental health and recovery services contributed to the decrease of nonfatal overdoses requiring hospitalization or emergency department visits (Center for American Progress, 2019). With the onset of the COVID-19 pandemic in March 2020, overdose rates began to rise nationwide as individuals navigated isolation, economic devastation, and a lack of availability to treatment resources (Wan & Long, 2020).

While the concern for opioid use increased over the past decade, the concern for pregnant women utilizing these drugs also increased. Recent trend data available from the Centers for Disease Control and Prevention (2018) indicated that women were prescribed opioids at a higher rate than men with estimates of 19.9 prescriptions written per 100 women versus 14.8 per 100 men. In addition to this data, Oei (2018) estimated that between the years 2008 to 2013, one in 10 mothers in the United States were prescribed opioid medication while pregnant for the treatment of pain from short-term and chronic illnesses as well as for the management of opioid dependence. This trend along with increases in illegal opiate use among pregnant women attributed to a nearly 300% increase in infants born with Neonatal Abstinence Syndrome (NAS) during the same time frame.

Neonatal withdrawal prevalence. Neonatal Abstinence Syndrome is classified by the International Classification of Diseases, 10th Revision, Clinical Modification system (ICD-10-CM) as neonatal withdrawal symptoms from maternal use of drugs of addiction (World Health Organization, 2018). NAS is most commonly associated with withdrawal from opioids. NAS can occur in two forms: prenatal and postnatal. Prenatal NAS occurs when the administration of drugs is discontinued by the pregnant mother. Postnatal NAS occurs when the administration is discontinued directly to the newborn infant.

The incidence of NAS in the United States increased from 1.5 in 1,000 births to 8.0 in 1,000 births from 2004 to 2014 (Winkleman, Villapiano, Kozhimannil, Davis, & Patrick, 2018). This fivefold increase in NAS prevalence translated to one infant born with NAS every 15 minutes in 2014 (Honein, Boyle, & Redfield, 2019). Additionally, a steady increase in NAS rates was observed nationwide through 2017, with variations observed in state-to-state comparisons (Hirai, 2021). Winkleman et al. (2018) found that rates of NAS births were significantly higher for infants insured with Medicaid from

2004 to 2014 compared to infants insured by private insurance. Individuals living in poverty report a higher rate of substance misuse as well an increase for the risk factors associated with addiction (Foundations Recovery Network, 2020). Of the infants with in-utero drug exposure to opioids, it is estimated that 75-90% of them will go on to receive a diagnosis of NAS at birth (Maguire et al., 2016). While NAS withdrawal symptoms typically last 48-72 hours postnatal (Jones & Fielder, 2015), the effects of the IUDE can hold long-term implications that can span the lifetime of development.

Initial Effects of NAS. Compared to infants without preterm drug exposure, infants born with NAS are more likely to experience lower birth weight, higher rates of preterm delivery (prior to 37 weeks gestation), and nearly all (97.1%) of babies born with NAS are admitted for longer stays in the NICU (Lind et al., 2015). Infant withdrawal symptoms are characterized by hyperirritability, gastrointestinal dysfunction (including excessive sucking, poor feeding, regurgitation, and diarrhea), tremors, high-pitched crying, increased muscle tone, seizures, nasal congestion, hyperthermia, and abnormal rapid breathing or tachypnea (MacMullen, Dulsk, & Blobaum, 2014). The average hospital stay of a healthy baby is 2.1 days while the average stay for a baby going through NAS is 16.9 days (Patrick, Davis, Lehmann, & Cooper, 2015). During this stay in intensive care units, babies with NAS will go through systematic withdrawal through pharmacotherapy with the use of opioids (Hall et al., 2015). The average cost for the treatment of infants with NAS is $66,700, an astounding increase from the average hospital cost of $3,500 for infants born in general good health (National Institute on Drug Abuse, 2015).

Biological basis of in-utero drug exposure. In utero drug exposure can have a multitude of effects on the developing fetus. Birth defects for babies born with NAS are reported 1.35 more times when compared to non-exposed infants; of these defects, impairments to the central nervous system are most commonly identified. Babies born with NAS are 16 times more like to be born with microencephaly and two to three times more like to develop cardiorespiratory defects (Auger et al., 2018).

The impact of in utero drug exposure on subsequent brain development has recently been studied. Nygaar et al. (2018) replicated brain neuroimaging studies to indicate that youth with opioid and poly-drug exposure prenatally retained smaller neuroanatomical brain volumes, regionally smaller cortical areas, and thinner cortex (Monnelly et al., 2018; Sirnes et al., 2017; Walhovd et al., 2007; Walhovd et al., 2010; Yuan et al., 2014). Nygaar et al. (2018) and Sirnes et al. (2018) also identified a reduction in volume specifically in the basal ganglia structure of the brain. Impairments to the basal ganglia could impact subsequent motor control, motor learning, executive functions and behaviors, and emotional regulation (Lanciego, Luquin, & Obeso, 2012). While research continues to emerge on the neuroanatomical impacts of NAS, further research with larger sample sizes is needed to delineate differences between the biological basis of NAS effects and developmental delays.

Long-Term Effects of NAS Relevant for the Education Field

Emerging research indicates many potential concerns over the span of development for infants born with NAS and in utero drug exposure when compared to non-exposed peers. This literature review will explore the long-term effects of NAS with a focus on ongoing health concerns and the potential effects on cognitive, language, visual, and language skill development. The impact of substance abuse as an adverse childhood experience will also be addressed.

Ongoing health concerns and cost. Ongoing support for infants born with NAS and in utero drug exposure involves a myriad of services. Services often include physical therapy, occupational therapy, speech therapy, social work and family services, and follow-up with medical clinics. Liu, Kong, Leslie, and Corr (2019) identified significantly greater health care use and cost associated with children born with NAS versus their non-exposed counterparts from birth to eight years of age. Children with NAS identified a greater need for inpatient hospital visits, outpatient hospital services, and prescription drug coverage, even after adjusting data from the newborn period in the NICU. Liu et al. (2019) identified a steady increase in prescription drug claims from three to seven years of age, a trend of importance to preschool and early elementary educators but did not specify the types of drugs administered to this population. Overall estimates of cost indicated that when compared to non-exposed counterparts, children with NAS accrued a little over 2.5 times the health care cost.

Long-term cognitive effects. When compared with non-exposed peers, children born with NAS and in utero drug exposure have been associated with significantly lower scores on cognitive assessments. Beckwith and Burke (2015) utilized the Bayley Scales of Infant and Toddler Development (Bayley-III) to discover lower cognitive scores in infants with NAS when compared to normative population data. Merhar et al. (2018) also found significantly lower cognitive abilities in toddlers with NAS at two years of age when compared to non-exposed same aged peers. Lower cognitive scores were also found to be persistent over early childhood development for children born with NAS.

Hunt, Tzioumi, Collins, and Jeffery (2008) assessed the cognitive abilities of toddlers born with NAS at 18 months of age with the Bayley-III then again at three years of age with the Stanford-Binet Intelligence Scales; they found that cognitive scores for both administrations were significantly lower for the toddlers with NAS when compared to healthy control infants. Yeoh et al. (2019) reviewed a variety of reliable and valid psychometric measures to determine the long-term impact of prenatal opioid exposure on cognitive abilities. Their findings revealed significantly lower cognitive scores on measures given to children with NAS between 0 and 24 months as well as for those aged three to six years. Findings between seven and 18 years indicated that cognitive scores were lower for this population, however due to the small sample size, could not be deemed significant. Based upon their findings, Yeoh et al. (2019) estimated that of the children with prenatal opioid exposure, 6.3% of them will have an IQ score two standard deviations below average. These figures become concerning when compared to the 2.3% of children estimated to fall under two standard deviations of the norm within the normal distribution.

The long-term cognitive abilities associated with children born with NAS need long-term commitment of study for educational teams to proactively anticipate potential needs of this population. A study implemented by Fill et al. (2018) found that children born with NAS were significantly more likely than non-exposed peers to be referred for an evaluation for special education between the ages of three and eight years. The children born with NAS also met the eligibility requirements for special education at a significant rate and required specially designed instruction and classroom therapies. The concern for differences in the classroom for children with prenatal opioid exposure was demonstrated in a longitudinal study from Oei et al. (2017). Their findings indicated that children born with NAS performed significantly lower on normed academic assessments. The deficits for this population also became more prolific over time when compared to same-aged peers.

Long-term language, motor, and visual effects. Numerous studies have indicated that NAS is associated with significantly lower language and motor abilities when assessed between birth and two years of age (Beckwith & Burke, 2015; Hunt et al., 2008; Merhar et al., 2018; Yeoh et al., 2019). When compared with a non-exposed control group, Hall, McAllister, and Wexelblatt (2019) found that children born with NAS were significantly more likely to receive a diagnosis of speech disorder and developmental delay. Merhar et al. (2018) further indicated visual effects of NAS, including a small percentage of children with strabismus that required corrective treatment.

Long-term effects on attentiveness and behavior. Sandtorv et al. (2018) discovered associations between NAS and attention deficit/hyperactivity disorder (ADHD) symptoms. School-aged children born with NAS were significantly more likely than a normative reference group to exhibit behaviors associated with inattention and hyperactivity/impulsivity. The same group of children with NAS were furthermore identified as having significant social difficulties.

Jaeger, Suchan, Schölmerich, Schneider, and Gawehn (2015) identified associations between prenatal drug exposure and ADHD symptoms. Their research further explored the differences in the ways that the drug exposed group attended to stimuli with neuroimaging techniques. Jaeger et al. (2015) found that children of early school-aged with prenatal drug exposure displayed longer reaction times and increased variability when presented stimuli than control groups of typically developing peers. Their findings also indicated that the exposed group of children stayed in a hypervigilant state with attentiveness patterns, leading to difficulties in differentiating and processing stimuli. Sirnes et al. (2018) further discovered lowered executive functioning and utilization of different prefrontal neural pathways on working memory tasks are observed in children exposed to opioids prenatally when compared to non-exposed peers. Additionally, Hall, McAllister, and Wexelblatt (2019) found that when compared with non-exposed peers, children born with NAS were significantly more likely to be diagnosed with behavioral or emotional disorders.

ACEs and environment. In their groundbreaking study of Adverse Childhood Experiences (ACE), Felitti et al. (1998) identified the following as indicators of childhood trauma: physical abuse, sexual abuse, emotional abuse, physical neglect, emotional neglect, exposure to domestic violence, household substance abuse, household mental illness, parental separation or divorce, and incarcerated household member. When considering the possible environmental experiences of a child born to parents struggling with substance abuse disorders, the risk of additional ACEs becomes apparent. Adverse childhood experiences negatively impact physical and mental health outcomes in adulthood (Felitti et al., 1998). Moreover, children with increased ACE indicators experienced more difficulty in the school setting. This finding is illustrated through increases in special health and developmental needs, behavioral and emotional needs, presentations of ADHD symptoms, and discipline and behavioral concerns (Bethell, Newacheck, Hawes, & Halfon, 2014). Therefore, environmental factors also need to be considered when assessing the academic, social, and emotional needs of students born with in utero drug exposure.

Potential Gaps in Services for Children with NAS

The lack of consistent terms, follow-up evaluations, and systematic research all contribute to our relatively weak understanding of how to serve children born with NAS and IUDE. There is also a need for future educators to better understand this population. Gaps in services for children with NAS also exist because there is a stigma associated with drug-related issues.

Defining, follow-up and systematic research. In order to solve any problem, the problem must first be clearly defined. However, recent research from Chiang, Okoroh, Kasehagen, Garcia-Saavedra, and Ko (2019) identified concerns about variance among states in identifying criteria for infants born with NAS as well as concerns about a lack of systematic surveillance of treatment. Their research highlights the importance of a systematic approach so that research is effectively tackling the correct concern and making accurate suggestions for public health interventions. Currently, there is not a consistent, unified approach for long-term follow-up for children born with NAS in the United States. Many studies indicate the need for larger sample sizes as well as longitudinal study approaches. Hunt et al. (2008) discovered through their systematic review that subject retention in longitudinal studies is difficult, especially when concerns for parental relapse and changes in custody are of concern with this subject population.

Systematic study is also difficult to ethically design with the population of children born with prenatal drug exposure. While hospitals can accurately pinpoint substances of prenatal exposure, the duration, intensity of use, and frequency and timing of use relies on parent report. Within research, there are inconsistencies reported for the long-term effects of prenatal drug exposure as well as the type of drug exposure underlying the NAS diagnosis. While a few emerging studies indicate long-term cognitive effects for children born with NAS, Konijnenberg and Melinder (2013) determined there were no cognitive differences between preschool-aged children exposed to buprenorphine, methadone, and nicotine when compared to non-exposed peers. A literature review from Conradt et al. (2019) further highlights inconsistencies in study design when examining the long-term effects of IUDE to control for covariates such as changes in environment of care and socioeconomic factors consistently.

Awareness of educators. As the medical field increases efforts for long-term follow-up, collaboration with school personnel to identify the needs of the child born with NAS and in utero drug exposure will become paramount. A lapse in communication could disrupt continuation of intervention services or identification of needs associated with the long-term effects of NAS. Educators will need professional development to increase their awareness of NAS and to reduce negative bias associated with this population.

Stigma. The stigma often associated with substance abuse disorders can carry into the experiences of families trying to support loved ones while navigating NAS. Howell, Smith, Lindsay, and Drury (2019) identified numerous barriers to maternal willingness to disclose relevant information around drug use that could identify the needs of the pregnant mother and expected child. Some of these barriers include fear of legal ramifications, perceived bias from medical providers, and maternal factors such as guilt.

Howell et al. (2019) highlighted the need for comprehensive support services to engage mothers and families to ultimately benefit the child.

Not only are families and providers tackling the stigma associated with substance abuse disorders, they could also be up against the stigma associated with other mental health disorders. According to Faherty, Matone, Passarella, and Lorch (2018), the mothers of infants with NAS and long-term prenatal opioid exposure had significantly higher prevalence rates for other mental health diagnoses including depression, anxiety, bipolar disorder, and schizophrenia. Part of the task of providing a sound support network for the families of children with NAS will be to advocate and connect families with mental health supports as needed as well.

Local Issues for Children with NAS

In response to the growing opioid epidemic and its impact on the greater Dayton region, many services have evolved to meet the community's needs. This section highlights local trends in the epidemic as well as the growing response to the population of children born with NAS and IUDE.

Local trends in the opioid epidemic. Cronholm et al. (2015) determined the adverse childhood indicators unique to minority sub-groups in Philadelphia and were able to identify extended ACEs to use to screen for supports within the community experience. The same concept should be applied to communities within the Dayton, Ohio radius, as Dayton led the drug-related death rate of the nation (ArrestRecords, 2014). Data compiled from the CDC and state health records determined that Dayton had a 50.6% drug overdose death rate. While other major U.S. cities reported higher numbers of overdose, Dayton claimed the highest percentage of deaths per population statistically.

A closer look at the local scope of the problem is revealed through data collected by the Joint Montgomery County/City of Dayton Working Session Presentations (Board of County Commissioners, 2016). Through their efforts, areas hit the hardest by the heroin epidemic have been identified. It stands to reason that the identified areas of Montgomery County could be serving individuals with long-term effects of NAS and IUDE at higher rates. Concern for the wellbeing of and exposure to trauma for children in drug-affected homes continues. According to Frolik (2015), the number of foster placements in Ohio solely due to parental drug abuse increased by 31% over the years of 2013 to 2014. The number of heroin-related protective services open cases rose in 2013 to 8.9 percent, an 80 percent increase over rates in 2010 (Frolik, 2015). Removals of children from their homes by children services decreased for the first time in 2018, following the first reported decline in opioid overdose deaths (Wedell, 2019). However, estimates of removals from 2013 to 2017 continued to increase by an estimated 20%, further straining an already exhausted system.

As national rates trended upwards with the COVID-19 pandemic beginning in March 2020, Dayton also witnessed a new surge in the overdose rates. According to a task force instituted by the Ohio Attorney General, more Ohioans died of an opioid overdose during the last three-months of 2020 than at any time since the epidemic began. Their data estimated the death rate in Ohio from opioid overdose at 11.01 per 100,000 population in the second quarter of 2020, the highest rate in 10 years. The previous 10-year high was in the first quarter of 2017 during the height of the opioid epidemic. At that time, overdose death rate were at 10.87 opioid overdoses per 100,000 population (Ohio Attorney General, 2021).

Increased NICU services and Brigid's Path. It is estimated that the number of pregnant women addicted to opiates in the greater Dayton, Ohio area is five times higher than reports from many other parts of the country (Miami Valley Foundation, 2019). During the incline of the opioid epidemic, local NICUs responded to a growing need for babies born with NAS. In 2015, Miami Valley Hospital launched the Promise to Hope program to provide intensive comprehensive care for infants born with NAS and their families.

In 2017, Brigid's Path (2016) opened as an inpatient NICU alternative care clinic for babies born with NAS. Brigid's Path works with families within a nonjudgmental framework to connect them with wrap around services. Families room-in at the facility and receive education and support in caring for their newborn with NAS. Shelby Borchers, Family Advocacy Supervisor, connects families with a constellation of services to improve the quality of care for infants. These services include identifying social work needs, coordinating and providing transportation for families to follow-up appointments, connecting families with dieticians and trained service providers for developmental therapeutic services, and providing community donated baby supplies (S. Borchers, personal communication, April 24, 2019).

Dayton Children's Hospital developmental follow-up clinic. Dayton Children's historically has provided a newborn follow-up clinic for infants receiving support in NICU. Over the past five years, there has been an influx of infants with NAS in the Dayton area. In August 2019, Dayton Children's Developmental Clinic increased time and services devoted to children with NAS specifically. Dayton Children's Developmental Clinic has provided follow-up for children born with NAS every three to six months up to age two with a focus on occupational needs (assessed with Peabody Developmental Motor Scales), speech needs (assessed with Rossetti Infant-Toddler Language Scales), motor and cognition screening (assessed with Capute Scales), speech development services, and support from social workers and nutritionists.

Dayton Children's NAS clinic is also starting to expand follow-up for children with NAS between two to five years with annual developmental monitoring (E. Boone, personal communication, September 5, 2019). Dayton Children's NAS clinic will begin to provide formal assessment for children with NAS beyond two years of age. In the future, overall development will be assessed using Bayley Scales of Infant Development, a scale that identifies cognitive, motor, social-emotional, and adaptive skills.

The Present Study

The Developmental Pediatrics Clinic at Dayton Children's Hospital observed patterns of concern for behavior for children born with NAS that include symptoms similar with diagnostic criteria for ADHD. The team also observed and documented mild cognitive concerns that could later impact learning abilities in follow-up measures with children born with NAS and IUDE. The present study aimed to examine the relationship between the variables that are associated with persistent developmental delays in children born with NAS and IUDE.

CHAPTER III

METHOD

Research Question

The purpose of this study was to determine the significance of the relationship between prenatal drug exposure and any subsequent developmental progress or delay in cognitive adaptive (visual motor) and receptive and expressive language domains. An additional purpose of this study was to examine differences between development for children diagnosed with Neonatal Abstinence Syndrome (NAS) and In Utero Drug Exposure (IUDE) compared to population norms of nonexposed children of the same age. Thus, this study explored the following research question: *What is the relationship between the variables that contribute to persistent developmental delays in cognitive adaptive (visual motor), expressive language, and receptive language in children born with NAS and IUDE from birth to two years of age?* Based on recent studies (Beckwith and Burke, 2015; Hall, McAllister, and Wexelblatt, 2019; Merhar et al., 2018), it was hypothesized that there would be significant deficits in visual motor ability and language skills for children in this study population. Based upon observation in practice, it was also hypothesized that differences would be indicated based upon the type of drug exposure.

Research Design

This study utilized a postpositivism quasi-experimental design, defined by Mertens (2020) as a study that examines quantitative data where participants are not randomly assigned to groups. A postpositivism quasi-experimental design was chosen because it allowed the researcher to examine historical data associated with diagnosed pre-existing conditions of NAS and IUDE. By using quasi-experimental methods, a wealth of descriptive and interferential statistical data was examined. Furthermore, this data can be utilized by Dayton Children's Hospital to guide their expansion of developmental services provided to the population of children born with NAS and IUDE.

Participants and Setting

Participants in this study were selected from approximately 460 patients seen by Dayton Children's Hospital developmental clinic from birth to two years of age for follow-up assessment for a diagnosis of NAS and/or IUDE between the years of 2015 to 2019. Participation in the present study were further determined based upon follow-up data available within the individual records. To be eligible, participants had to have a diagnosis of NAS and/or IUDE and had at least two developmental assessments with Dayton Children's developmental follow-up clinic between birth and two years of age. These two assessments had to be between 10 months and 24 months apart. Individuals with a diagnosis of NAS and/or IUDE but lacking a complete assessment history were not included in the present study. Individuals with a diagnosis of Fetal Alcohol Syndrome or Fetal Alcohol Spectrum Disorder were also excluded from study. Altogether, a total of 106 participants met the requirements for the present study.

Instruments

Two psychometric assessments were utilized in a time series design for data collection and analysis for this study. Both instruments were administered by one to two trained and experienced health care providers at Dayton Children's Hospital. The Capute Scales (Accardo & Capute, 2005) was utilized to determine an individual's cognitive adaptive abilities and was used by clinicians to identify the presence of atypical development in children from birth to three years of age. Developmental quotients were determined for the Cognitive Adaptive Test (CAT), a test of visual-motor skills with 57 items and the Clinical Linguistic and Auditory Milestone Scale (CLAMS), a test of 26 expressive and 17 receptive milestones. A Full-Scale Developmental Quotient can be comprised of the two subscales. Developmental Quotients were calculated by dividing the age-equivalent score by the chronological age. This was then multiplied by 100. Developmental Quotients quantified an individual's scores and allowed the researcher to determine the standard deviation of the score. For the present study, only the CAT scores of the Capute Scales were available to be recorded.

The Capute Scales scores were normed with populations based in the Midwest and Central United States. The normative sample size included 1,055 children between the ages of two and 36 months of age. The standardization study demographics sought equal representation of gender, and race representation was 56.7% Caucasian, 32.3% African American, and 11% Other. Individuals with known developmental conditions were excluded from the normative process. Accardo and Capute (2005) indicate concurrent validity between The Capute Scales and the Bayley Scale of Infant Development, a measure with five components: a cognitive scale, a language scale, a motor scale, a socio-emotional scale, and an adaptive scale. A strong correlation between The Capute Scales and the Bayley Scale of Infant Development was demonstrated by Kube, Wilson, Peterson, and Palmer (2000) as well as by Voight et al. (2007). Direct reliability measures are not reported by Accardo and Capute (2005); however, the test participants selected for the normative study had to demonstrate a minimum of at least 80% reliability in order to serve as an evaluator of the test. Strong interrater reliability in scoring (unweighted kappa coefficient = 0.95) for The Capute Scales was demonstrated in a study by Pittock, Juhn, Adegbenro, and Voigt (2002).

The Rossetti Infant-Toddler Language Scale (Rossetti, 2006) assessed the preverbal and verbal aspects of communication and interaction in children from birth to three years of age. Subtests of the Rossetti Infant-Toddler Language Scale included: Interaction Attachment, Pragmatics, Gesture, Play, Language Comprehension, and Language Expression. Scores obtained indicated mastery and emerging skills and determined delays in expressive and receptive language domains. The test administrator was able to determine if a skill is present through observation, trying to elicit the wanted response, or by parent/guardian report. The Rossetti Infant-Toddler Language Scale provided results that indicated the mastery of skills and are reflected in three-month age intervals. The Rossetti Infant-Toddler Language Scale is a criterion-referenced and norm-referenced measure. This measure was normed based on a sample of 357 children from ages four to 36 months. Of this normative sample, every age interval had 60 children each. The normative sample had equal representation for age and attempts were made to incorporate different ethnic backgrounds as well as socioeconomic statuses. The reliability of the scores from the normative sample was determined to be .88 to .99 (L. Rossetti, personal communication, December 23, 2019; Infant & Toddler Connection of Virginia, 2017). As a criterion-referenced measure, in-depth information about reliability and validity were not readily available.

Procedures

This study was submitted for approval by The University of Dayton's IRB and Dayton Children's Hospital IRB. A reliance agreement was submitted for the collaboration between Dayton Children's Hospital and the University of Dayton.

Recruitment and consent. The researcher conducted a retrospective chart review through an electronic medical record search to identify study participants. Through the IRB approval process, parental consent was not required for the historical chart review. No direct contact was made between the researcher and the study participants.

Data collection. Data was collected for all eligible study participants and included: (a) gender; (b) race; (c) diagnosis type: NAS and/or IUDE; (d) type(s) of prenatal illicit drug exposure as determined by laboratory analysis at the time of birth; (e) environment of care: foster care, kinship care, or in the care of biological parent(s). Kinship care was defined as placement with biological relative(s) that are not biological parent(s).; (f) identified disorders as appropriate; (g) identification of therapeutic services; (h) age-equivalent Cognitive Adaptive Test (CAT) scores assessed by The Capute Scales from birth to two years of age.; (i) age-equivalent expressive and receptive language scores assessed by the Rossetti Infant-Toddler Language Scale from birth to two years of age.

Data was collected according to the Health Insurance Portability and Accountability Act (HIPAA). HIPAA requires the confidential handling of personal, protected health information (Office for Civil Rights, n.d.); therefore, no personally identifiable information was collected or reported through this study. Each participant was assigned a random number to ensure confidentiality. The master list of study participants was only accessible by Dayton Children's Hospital (DCH) secure email between the accounts of the main researchers Emily Boone, Nurse Practitioner at DCH and Elizabeth Staley, University of Dayton School Psychology graduate thesis student who was a volunteer at DCH with approved EPIC access. All data collected regarding participants was kept secure on a USB drive which was kept in a locked location at DCH.

Data Analysis

A series of statistical analyses were conducted to answer the research question**:** *What is the relationship between the variables that contribute to persistent developmental delays in cognitive adaptive (visual motor), expressive language, and receptive language in children born with NAS and In IUDE from birth to two years of age?* The independent variable of this study was the type of drug exposure. The dependent variable was the Cognitive Adaptive Test scores on The Capute Scales and the expressive and receptive language scores on Rossetti Infant-Toddler Language Scale. Covariates of this study included the type of diagnosis assigned at birth, gender, and environment of care. More in-depth breakdown of data analysis is discussed further in Chapter IV.

Statistical analysis. Descriptive statistics were provided including mean, standard deviation, and range of scores for the participants in the study. The percentage of participants in relation to basic demographic data was given. Inferential statistics were calculated to determine the relationship between the variables that contributed to persistent developmental delays in children born with NAS and IUDE and were as follows:

Series 1 Research Sub-Questions: Scores at initial assessment

- Research Sub-Question 1a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) compared with expected outcome values at the initial assessment?

- Research Sub-Question 1b: Was there a significant difference in receptive language (Rossetti scores) compared with data from non-exposed groups at the initial assessment?

- Research Sub-Question 1c: Was there a significant difference in expressive language (Rossetti scores) compared with data from non-exposed groups at the initial assessment?

One-sample t-tests and chi-squared tests were used in determining statistical significance of Series 1, Question 1 research sub-questions.

Series 2 Research Sub-Questions: Scores at final assessment

- Research Sub-Question 2a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) compared with expected outcome values at the final assessment?

- Research Sub-Question 2b: Was there a significant difference in receptive language (Rossetti scores) compared with data from non-exposed groups at the final assessment?

- Research Sub-Question 2c: Was there a significant difference in expressive language (Rossetti scores) compared with data from non-exposed groups at the final assessment?

One-sample t-tests and chi-squared tests were used in determining statistical significance of Series 2, Question 2 research sub-questions.

Series 3 Research Sub-Questions: Changes over time and interaction effects

- Research Sub-Question 3a: To what degree does cognitive adaptive measure (Capute rate of change score) change over time based on type of drug exposure?

- Research Sub-Question 3b: To what degree does receptive language development (Rosetti rate of change score) change over time based on type of drug exposure?

- Research Sub-Question 3c: To what degree does expressive language development (Rosetti rate of change score) change over time based on type of drug exposure?

One-way ANOVA was used in determining statistical significance of Series 3, Question 3 research sub-questions.

Series 4 Research Sub-Questions: Differences Based on Diagnosis

- Research Sub-Question 4a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment?

- Research Sub-Question 4b: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) based on diagnoses of NAS/IUDE and IUDE only at the final assessment?

- Research Sub-Question 4c: To what degree does the cognitive adaptive measure (Capute rate of change score) change over time based on diagnosis?

- Research Sub-Question 4d: Was there a significant difference in receptive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment?

- Research Sub-Question 4e: Was there a significant difference in receptive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the final assessment?

- Research Sub-Question 4f: To what degree does receptive language (Rossetti rate of change score) change over time based on diagnosis?

- Research Sub-Question 4g: Was there a significant difference in expressive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment?

- Research Sub-Question 4h: Was there a significant difference in expressive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the final assessment?

- Research Sub-Question 4i: To what degree does expressive language (Rossetti rate of change score) change over time based on diagnosis?

Independent t-tests were used in determining statistical significance of Series 4, Question 4 research sub-questions.

Microsoft Excel and SPSS were utilized to run statistical analysis.

CHAPTER IV

RESULTS

A total of 106 participants were included in the present study. Population demographics and birth characteristics are shown in Table 1.

Table 1
Demographics and Birth Characteristics of Study Participants

Gender	Number	Percentage
Male	61	57.5%
Female	45	42.5%
Race		
White	83	78.3%
Black	13	12.3%
Biracial	3	2.8%
Pacific Islander	1	0.9%
Other/Unspecified	6	5.7%
Diagnosis		
NAS & IUDE	80	75.5%
IUDE only	26	24.5%
Initial Environment		
Foster Placed	49	46.2%
Kinship Care	26	24.5%
Biological Parents	27	25.5%
Foster- Adopted	4	3.8%

Overall, 62.3% of study participants had no change in their environment of care during the study timeframe. Of the children who were in foster care placement, 26.4% were adopted by their foster families by the final assessment timeframe. Finally, 6.6% of children went into kinship care and 2.8% returned to their biological parent(s). Additionally, data was collected for this population to determine the prevalence of related diagnoses and therapeutic services provided. Appendix A provided definitions for medical terminology associated with diagnoses. It is important to note that these diagnoses and therapies were present within participants record and may have occurred after the 24-month mark outlined with the study methods. These statistics are represented in Table 2.

Table 2
Related Diagnoses and Services of Study Participants

Diagnosis Category	Diagnoses Included	Number	Percentage
Behavior	Behavior Disorder	13	12.3%
Attentiveness	ADHD/Hyperkinetic	10	9.4%
Developmental Delay	Developmental Delay	31	29.2%
Speech/Language Disorders	Speech Delay, Articulation Deficiency, Mixed Expressive/Receptive Language Disorder, Apraxia	49	46.2%
Fine Motor Delay	Fine Motor Delay	6	5.7%
Gross Motor Delay	Gross Motor Delay	4	3.8%
Vision	Exotropia, Strabismus, Nystagmus	4	3.8%
Physical Development Deformity	Microcephalic, Brachycephaly, Craniosynostosis, Macroencephaly	8	7.5%
Therapeutic Service			
Speech and Language Therapy		40	37.7%
Occupational Therapy		19	17.9%
Physical Therapy		21	19.8%

Prenatal illicit drug exposure as determined by laboratory analysis at the time of birth was recorded for each study participant. The overall number and type of drug exposure is reflected in Table 3.

Table 3
Occurrence and Type of Prenatal Illicit Drug Exposure

Number	Number	Percentage
Participants with 1 drug exposure	36	34%
Participants with 2 drug exposure	32	30.2%
Participants with 3 drug exposure	22	20.8%
Participants with 4 drug exposure	9	8.5%
Participants with 5 drug exposure	7	6.5%
Participants with polydrug exposure	64	66%
Type		
Heroin Exposure	56	52.8%
Opiate Unspecified Exposure	33	31.1%
Fentanyl Exposure	2	1.9%
Subutex/Suboxone Exposure	24	22.6%
Methadone Exposure	13	12.3%
Cocaine Exposure	38	35.8%
Buspar/Anxiolytics Exposure	1	0.9%
THC Exposure	34	32.1%
Benzodiazepine Exposure	15	14.2%
Amphetamine Exposure	17	16%
Barbiturate Exposure	4	3.8%

The Capute Cognitive Adaptive Test Developmental Quotient (CAT DQ) was calculated by dividing the age equivalent by the chronological age and multiplying by 100 to determine a percentage, as recommended by the authors of the instrument. The CAT DQ was an expression of the percentage of expected development demonstrated at the time of evaluation. Ideally, if a child was developing at the same rate as their same age peers, then the developmental quotient score would be 100. Based upon the standardization of the measure, Accardo and Capute (2005) determined that a CAT DQ score of 100 fell at the 50th percentile while a score of 81 fell at the 10.30th percentile. Limited information was available for norm-referenced standard deviation scores for this measure.

The Rossetti Infant-Toddler Language Scale was a criterion-referenced and norm-referenced measure and provided a chronological age range equivalent for receptive and expressive language development. This age range was recorded for each study participant at the initial and final assessment. Then, a nominal qualifier was determined and indicated whether the participant was “below”, “at”, or “above” the expected range of development for their chronological age.

CAT DQ scores and Rossetti chronological age equivalents for receptive and expressive language scores at the initial assessment were recorded for the present study. Ages at the initial assessment ranged from 1.6 months to 13.0 months, with a mean of 4.9 months for the chronological age. Similarly, scores at the final assessment were recorded for CAT DQ and Rossetti chronological age equivalents for receptive and expressive language scores for the final assessment. Ages at the final assessment ranged from 12 to 24 months, with a mean age of 19.4 months. The time between initial and final assessments ranged from 10 to 22 months, with a mean of 14.5 months for the study population. These data were utilized to determine the following research questions.

Series 1 Research Sub-Questions: Scores at Initial Assessment

Research Sub-Question 1a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) compared with expected outcome values at the initial assessment? Scores for the CAT DQ for the study population were represented visually in Figure 1.

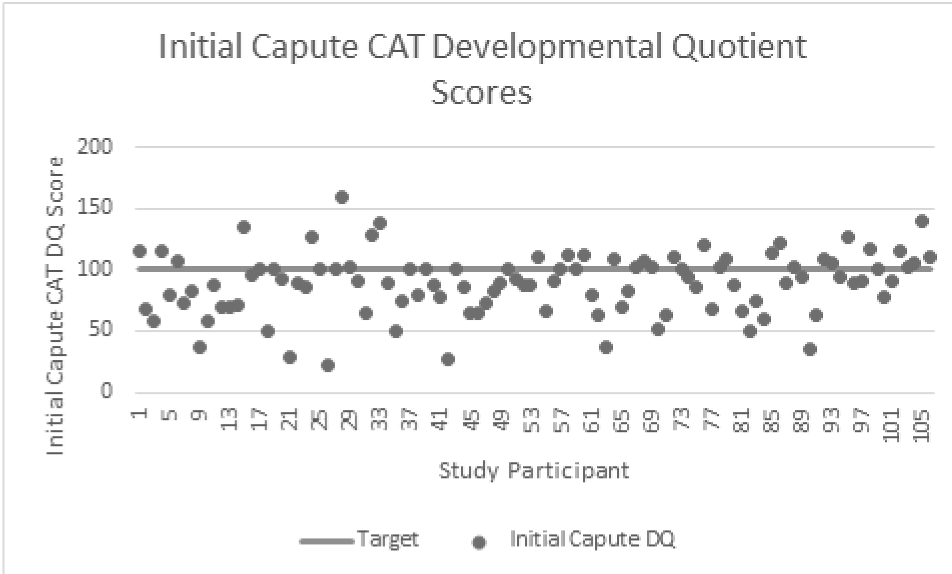

Figure 1. Initial Capute CAT DQ Scores

Initial CAT DQ scores for the study population ranged from 22 to 160, with a mean of 88.62 and a standard deviation of 25.23. To determine the statistical significance of the initial scores compared with the expected score of 100, a one-sample t-test was conducted. The CAT scores on the cognitive adaptive test at the initial assessment were significantly below the expected value of 100, $t(105)= -4.642$, $p= .00$.

Research Sub-Question 1b: Was there a significant difference in receptive language (Rossetti scores) compared with data from non-exposed groups at the initial assessment? The present study lacked a control group for comparison data. Therefore, rates of language development delay were sought from recent, relevant research. According to a study conducted by Hall, McAllister, and Wexelblatt (2019) speech and language disorders for non-exposed peers of the same developmental timeframe were evidenced in 6.5% of cases. These rates were used to determine expected rates of participants within the below, at, and above ranges for the present study. A visual representation of the receptive language scores at the initial assessment for the study population were found in Figure 2.

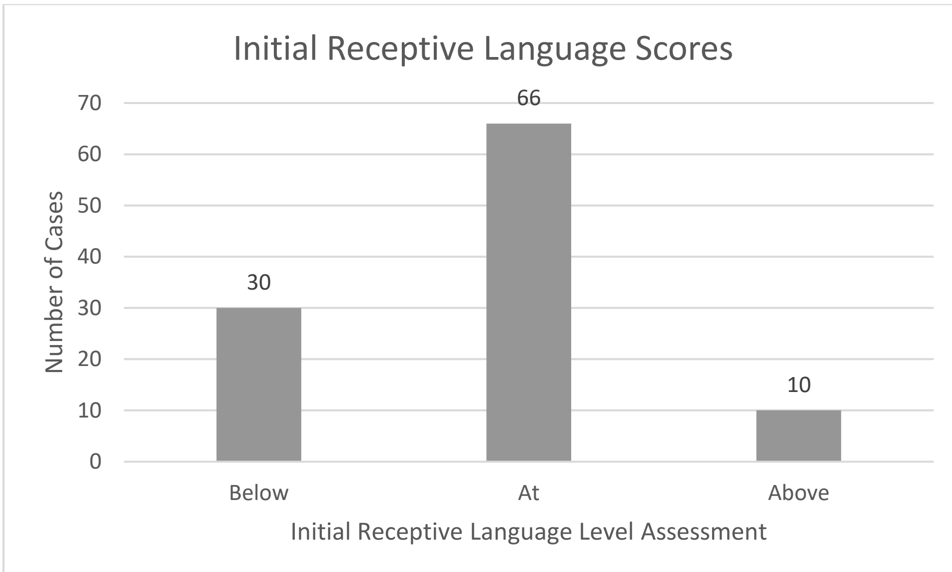

Figure 2. Initial Receptive Language Assessment Levels

At the initial assessment, 30 participants fell below the range of expected development, 66 fell within the range of expected development, and 10 were above the expected range for receptive language development. A chi-squared test with calculated expected values was run to determine how the study population compared with non-exposed population. Compared with a normative sample, scores on the initial receptive language assessment were significantly more varied; significantly more children in this study scored below the expected range. X^2 (2, N=106)= 82, *p*= .00.

Research Sub-Question 1c: Was there a significant difference in expressive language (Rossetti scores) compared with data from non-exposed groups at the initial assessment? Identical processes were utilized to determine the qualifiers and levels for the expressive language scores that were described for the receptive language scores. Similarly, rates of speech and language delay for non-exposed peers highlighted in the research were used for expressive language. Visual representation of the study population scores at the initial assessment for expressive language were indicated by Figure 3.

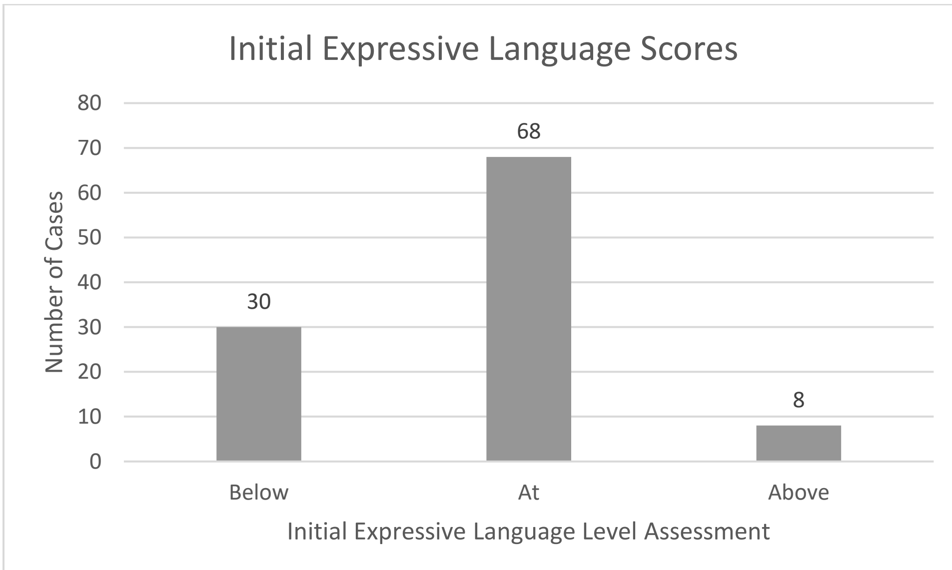

Figure 3. Initial Expressive Language Assessment Levels

At the initial assessment, 30 participants were below the range of expected development, 68 fell within the range of expected development, and 8 were above the expected range for expressive language development. A chi-squared test with calculated expected values was run to determine how the study population compared with non-exposed population. Compared with a normative sample, scores on the initial expressive language assessment were significantly more varied; significantly more children in this study scored below the expected range. X^2 (2, N=106)= 81, p= .00.

Series 2 Research Sub-Questions: Scores at final assessment

The evaluation process detailed in Series 1 Research Sub-Questions was also applied to Series 2 Research Sub-Questions.

Research Sub-Question 2a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) compared with expected outcome values at the final assessment? Visual representation of final CAT DQ scores were represented by Figure 4.

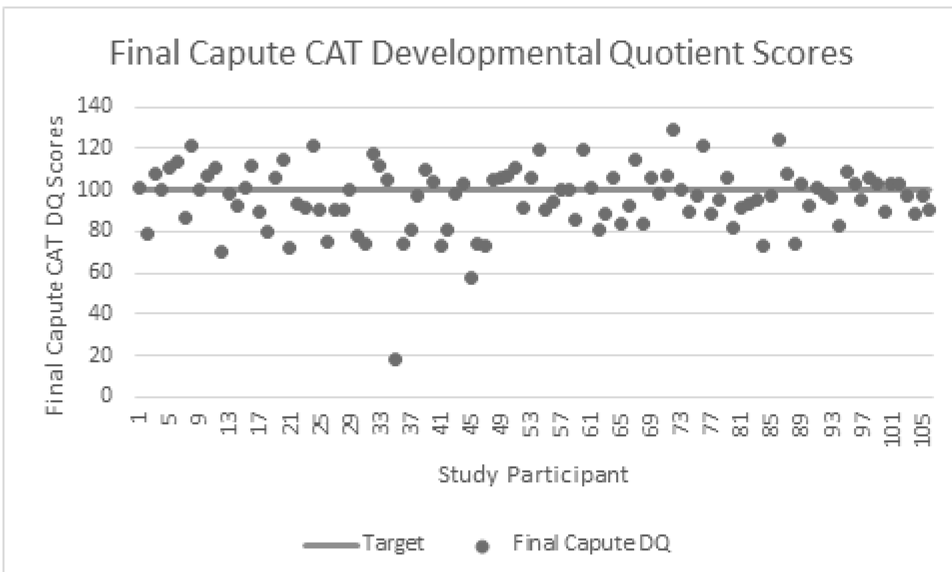

Figure 4. Final Capute CAT DQ Scores

Final CAT DQ scores for the study population ranged from 18 to 129, with a mean of 96.01 and a standard deviation of 15.61. To determine the statistical significance of the initial scores compared with the expected score of 100, a one-sample t-test was run. The CAT scores on the cognitive adaptive test at the final assessment were significantly below the expected value of 100, $t(105)$= -2.632, p= .01.

Research Sub-Question 2b: Was there a significant difference in receptive language (Rossetti scores) compared with data from non-exposed groups at the final assessment? Figure 5 represented the outcomes for the study population for receptive language development at the final assessment.

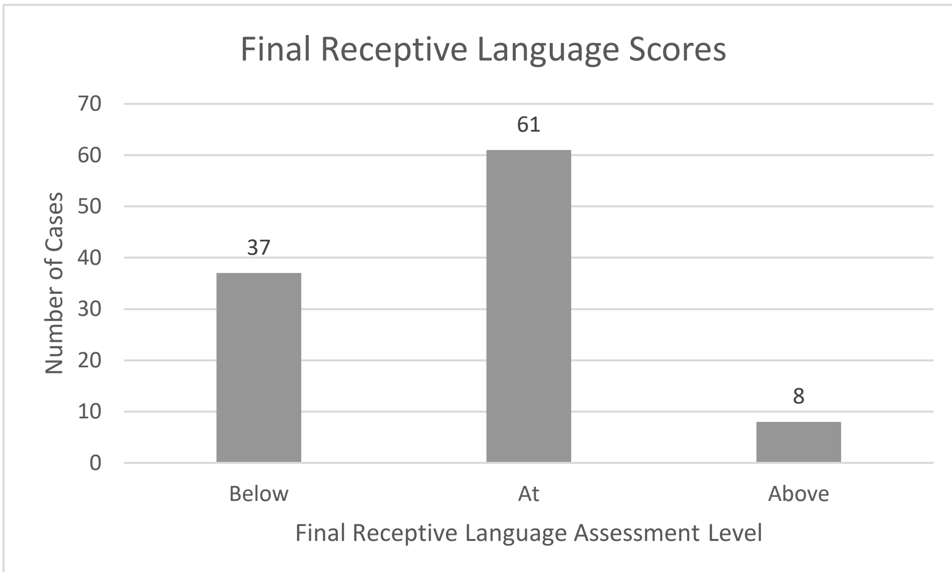

Figure 5. Receptive Language Level at Final Assessment

At the final assessment, 37 participants were below the expected level of development, 61 were within the expected level, and 8 participants scored above the expected range for receptive language development. Compared with a normative control group, scores on the final receptive language assessment were significantly more varied; Significantly more children in this study scored below the expected range, X^2 (2, N=106)= 138, p= .00. Compared with the initial receptive language assessment, more children were below the developmental range for receptive language.

Research Sub-Question 2c: Was there a significant difference in expressive language (Rossetti scores) compared with data from non-exposed groups at the final assessment? Figure 6 described the outcomes for study participants for expressive language at the final assessment.

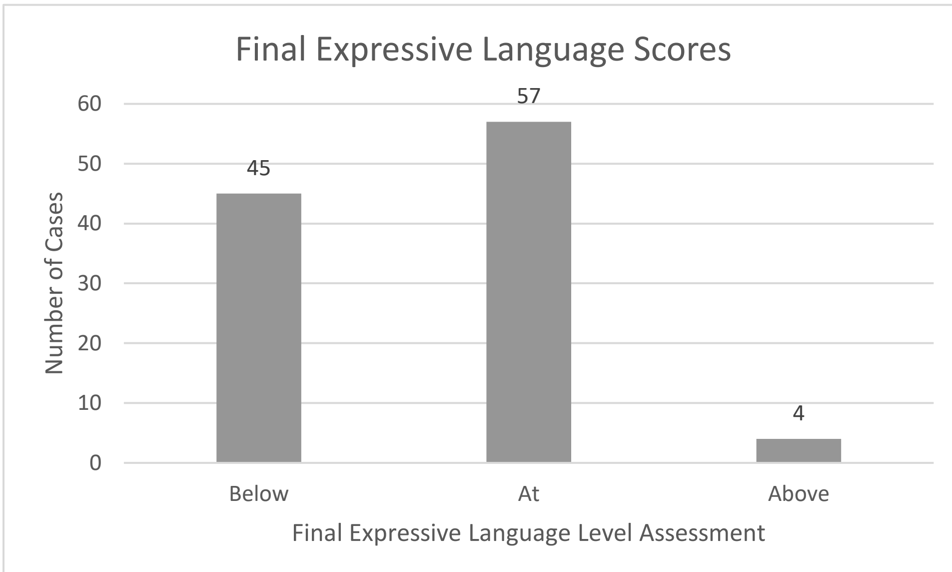

Figure 6. Final Expressive Language Assessment Levels

At the final assessment, 45 participants were below the expected developmental range, 57 were within the expected range, and 4 were above the expected range for expressive language. Compared with a normative control group, scores on the final expressive language assessment were significantly more varied; Significantly more children in this study scored below the expected range, X^2 (2, N=106)= 221, p= .00. Compared with the initial expressive language assessment, more children were below the developmental range for expressive language.

Series 3 Research Sub-Questions: Changes over time and interaction effects

To calculate the rate of change, the difference between the final and initial scores was calculated. This number was then divided by the difference in time between assessments.

Research Sub-Question 3a: To what degree does cognitive adaptive measure (Capute rate of change score) change over time based on type of drug exposure? The rate of change for CAT DQ scores was represented by Figure 7.

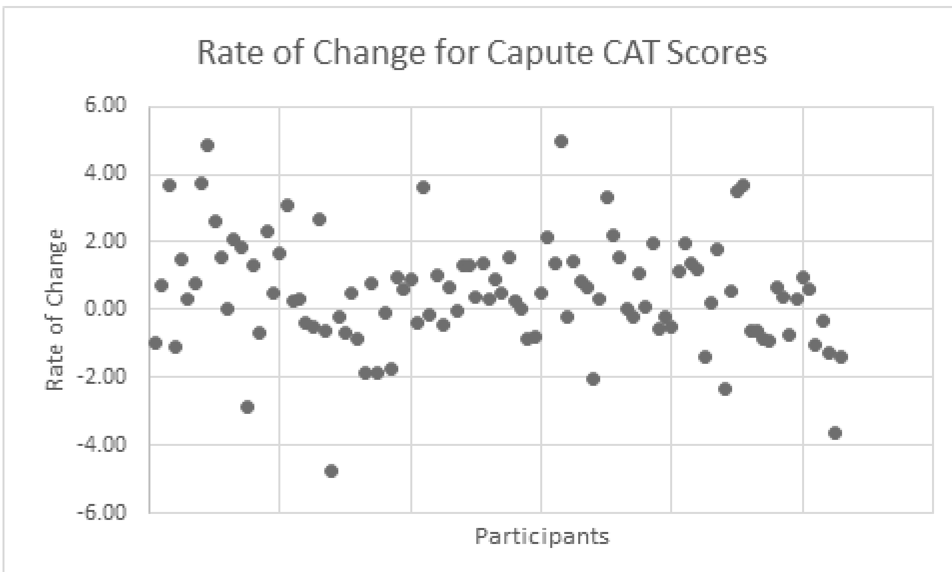

Figure 7. Rate of Change for CAT DQ Scores

The rate of change for the CAT DQ scores ranged from - 4.77 to 4.99 with a mean of 0.5 and a standard deviation of 1.62. A one-way ANOVA was conducted to determine the level significant relationship between CAT DQ rate of change scores and drug type. None of the significance levels were below *p*=.05, therefore there was not a significant relationship between CAT DQ rate of change scores and the type of drug exposure.

Research Sub-Question 3b: To what degree does receptive language development (Rosetti rate of change score) change over time based on type of drug exposure? The rate of change for receptive language development was detailed in Figure 8.

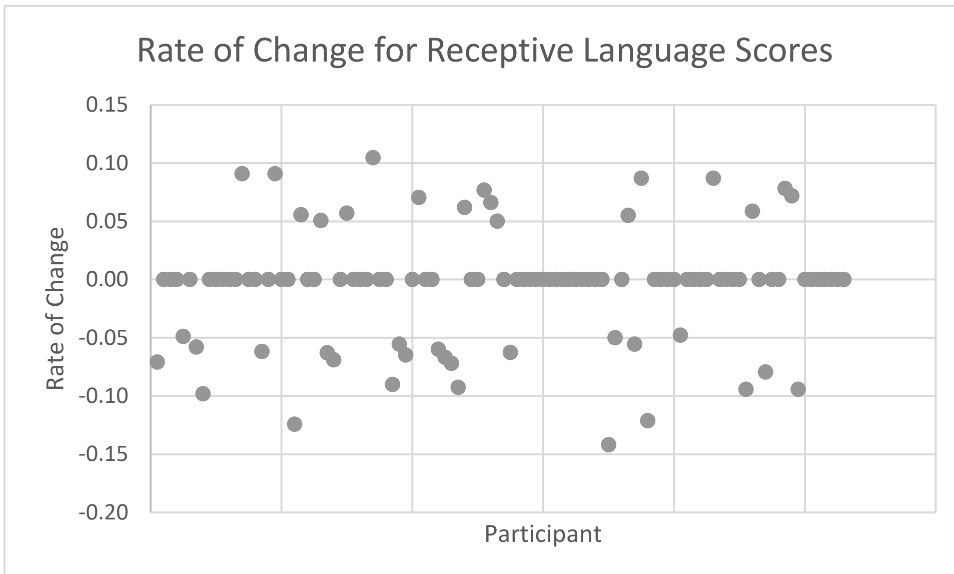

Figure 8. Rate of Change for Receptive Language Development

The rate of change for receptive language development ranged from -0.14 to 0.10. The average rate of change for receptive language scores was -.0057, with a standard deviation of .04. A one-way ANOVA was conducted to determine the level significant relationship between the rage of change receptive language scores and drug type. None of the significance levels were below p=.05, therefore there was not a significant relationship between the receptive language rate of change scores and the type of drug exposure.

Research Sub-Question 3c: To what degree does expressive language (Rosetti rate of change score) change over time based on type of drug exposure? Figure 9 depicted the rate of change scores for expressive language development.

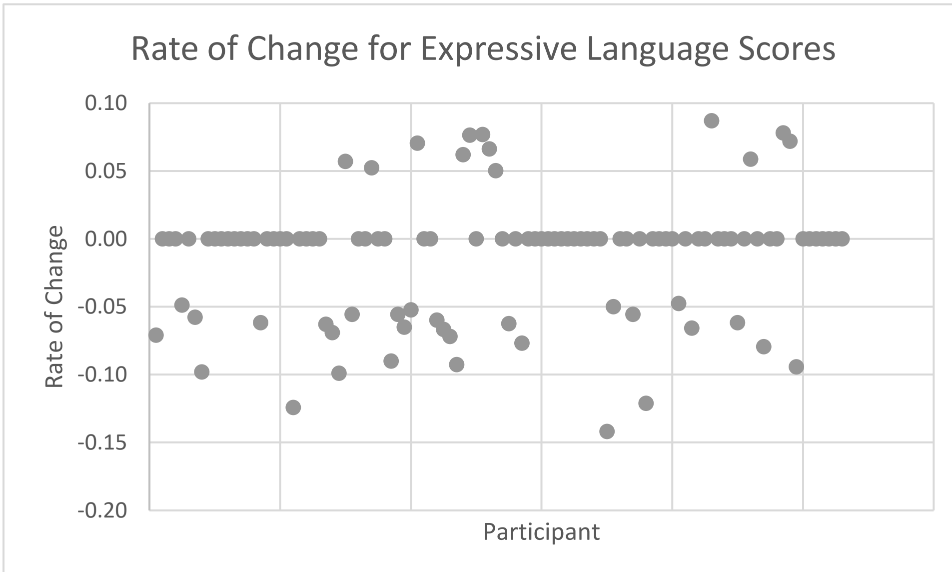

Figure 9. Rate of Change for Expressive Language Development

The rate of change for expressive language development ranged from -0.14 to 0.09. The average rate of change for expressive language scores was -.0126, with a standard deviation of .04. A one-way ANOVA was conducted to determine the level significant relationship between the rage of change expressive language scores and drug type. None of the significance levels were below *p*=.05, therefore there was not a significant relationship between the expressive language rate of change scores and the type of drug exposure.

Series 4 Research Sub-Questions: Differences Based on Diagnosis

There were 80 participants with the diagnosis of NAS and IUDE combined. There were 26 participants with a diagnosis of IUDE only in the present study.

Research Sub-Question 4a: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment? Capute CAT DQ scores were broken down by diagnosis and represented in Figure 10.

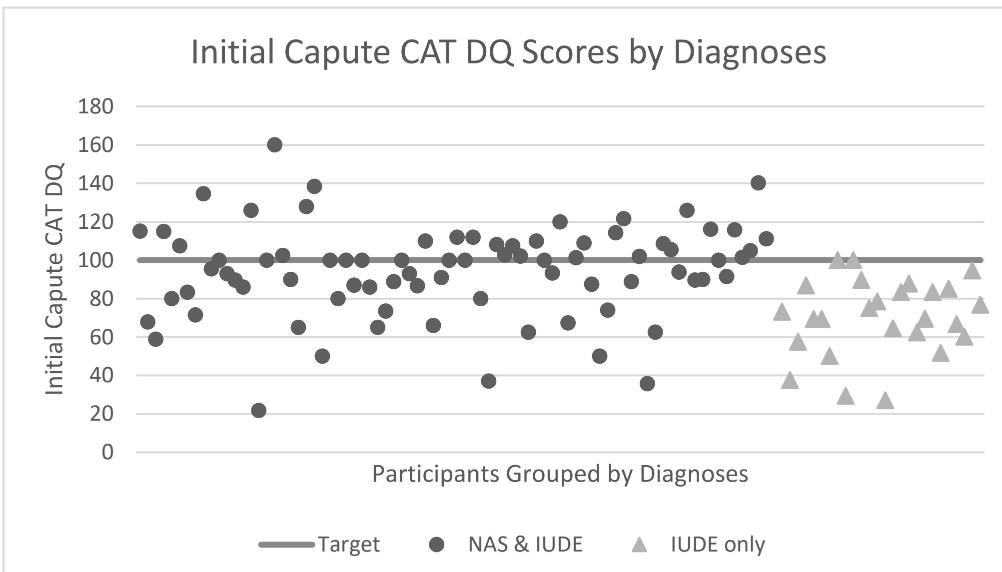

Figure 10. Initial CAT DQ Scores Grouped by Diagnosis

CAT DQ scores for participants in the NAS and IUDE group at the initial assessment had a mean of 94.56 and a standard deviation of 24.01. In contrast, scores for participants in the IUDE only group had a mean of 70.35 and a standard deviation of 19.76. An independent samples t-test was conducted to determine statistical significance of the difference between scores based upon diagnosis. Significant differences for initial CAT DQ scores were found based upon diagnosis, $t(106)= 5.135$, $p= .00$.

Research Sub-Question 4b: Was there a significant difference in cognitive adaptive measure (Capute Developmental Quotient score) based on diagnoses of NAS/IUDE and IUDE only at the final assessment? Figure 11 demonstrated the differences in final CAT DQ scores based upon diagnosis.

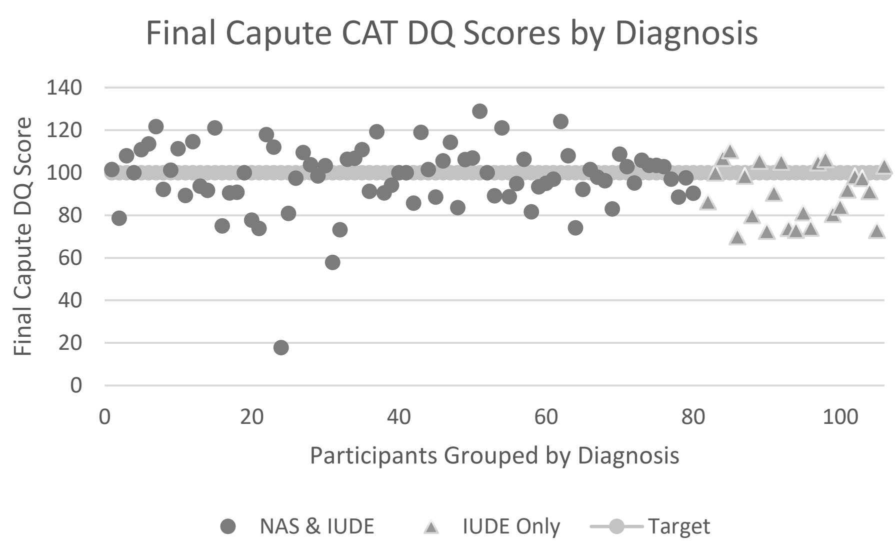

Figure 11. Final CAT DQ Scores Grouped by Diagnosis

At the final assessment, participants in the NAS and IUDE group had a mean CAT DQ score of 97.86 and a standard deviation of 16.01. Participants in the IUDE only group had a CAT DQ mean score of 90.31 and a standard deviation of 12.97. An independent samples t-test was conducted to determine if the differences between the two groups were significant. Significant differences for the final CAT scores were found based upon diagnosis, $t(106)= 2.428$, $p=0.19$.

Research Sub-Question 4c: To what degree does the cognitive adaptive measure (Capute rate of change score) change over time based on diagnosis? Children with the IUDE only diagnosis scored significantly lower both intervals of CAT DQ assessments. However, participants in the IUDE only group had a mean rate of change for the CAT DQ of 1.39. The standard deviation for the IUDE only group was 1.27. In contrast, the mean rate of change for the CAT DQ scores of the NAS and IUDE group was 0.21 with a standard deviation of 1.62. An independent samples t-test was conducted to determine the level of significance for the rate of change based on diagnosis. It was determined that there was a significant difference in the rate of change based upon diagnosis, $t(106) = -3.373$, $p = .001$. Children with the IUDE only diagnosis had a significantly higher rate of change when compared with children in the NAS and IUDE group. Scores for children with the IUDE only diagnosis were more likely to show a positive trend.

Research Sub-Question 4d: Was there a significant difference in receptive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment? Figure 12 demonstrated the differences in receptive language at the initial and final assessments based upon diagnosis group.

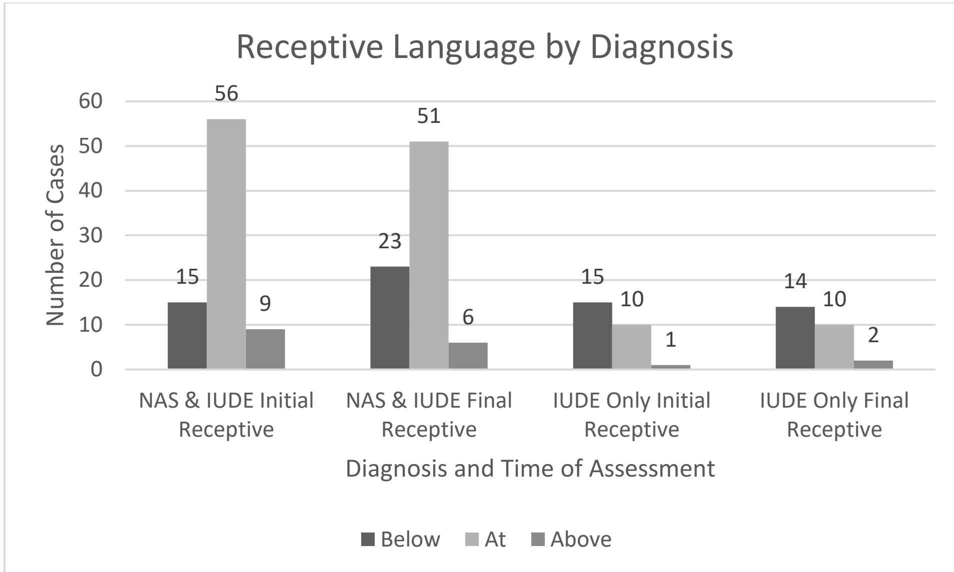

Figure 12. Receptive Language Development by Diagnosis

A significant difference was indicated at the initial receptive language assessment based on diagnosis, $t(106)= 3.7$, $p=.00$. However, this trend was not observed at the final assessment for receptive language or for the rate of change.

Research Sub-Question 4e: Was there a significant difference in receptive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the final assessment? At the final assessment, there was not a statistically significant difference between the two diagnosis groups, $t(106)= 1.979$, $p=.063$.

Research Sub-Question 4f: To what degree does receptive language (Rossetti rate of change score) change over time based on diagnosis? Statistically significant differences were not observed based upon diagnosis for the receptive language rate of change, $t(106)= -1.354$, $p=.179$.

Research Sub-Question 4g: Was there a significant difference in expressive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the initial assessment? Figure 13 highlighted the differences in expressive language development based upon diagnosis.

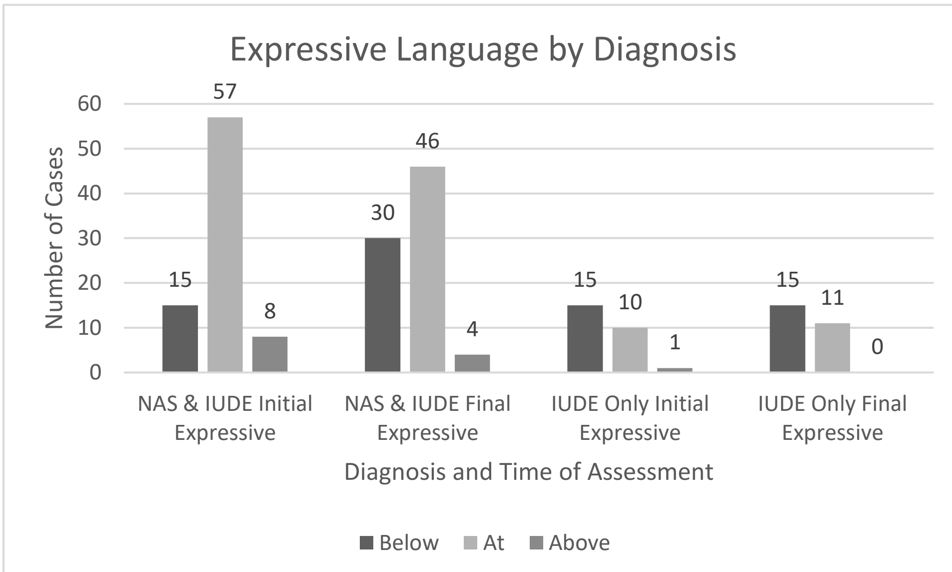

Figure 13. Expressive Language Development by Diagnosis

Significant differences were found based upon diagnosis at the initial expressive language assessment, $t(106)= 3.668$, $p=.00$. Proportionally, more children in the IUDE only group were below the expected range of development for expressive language.

Research Sub-Question 4h: Was there a significant difference in expressive language (Rossetti scores) based on diagnoses of NAS/IUDE and IUDE only at the final assessment? Diagnosis continued to be a significant indicator for expressive language development at the final assessment, $t(106)= 2.144$, $p=.037$.

Research Sub-Question 4i: To what degree does expressive language (Rossetti rate of change score) change over time based on diagnosis? Diagnosis was not a significant indicator of the rate of change for expressive language, $t(106) = -1.188$, $p = .238$.

CHAPTER V

DISCUSSION

Review of Purpose and Major Findings

The purpose of this study was to determine the long-term developmental outcomes of children who had prenatal drug exposure. By studying these outcomes, educational teams can develop a better understanding of the potential needs of this given population, especially as they transition from intervention and support in the clinical setting to the school setting.

Results from this study indicated that scores for CAT DQ scores were significantly lower than the expected value that would indicate development in visual motor skills at a rate similar to same age peers. These results were consistent at the initial and final assessments. CAT DQ rates of change were not significantly impacted by type of drug exposure but were influenced by diagnosis. Participants in the IUDE only diagnosis group had a positive, significant rate of change for the CAT DQ scores. This means that the IUDE only group realized significant growth in scores over time whereas, the rate of change for the NAS and IUDE group was not significant. Children in the IUDE only group made gains to close the observed deficit gap.

Compared to rates of speech and language delay for non-exposed peers, participants were significantly below the expected rate of development for receptive and expressive language at initial and final assessments. More children fell below the expected level of language development at the final assessment when compared to the initial assessment. There was not a significant relationship between the rate of change for receptive and expressive language development and the type of drug exposure or diagnosis.

Interpretation of Findings Relative to the Hypothesis

It was hypothesized that the visual motor scores (Capute CAT scores) for study participants would be significantly below the expected range of development. Results from the present study confirmed that the visual motor scores were significantly below the expected value that would indicate typical development in this area. Although both assessment points yielded results that were significantly lower than the expected value, the level of deficit was greater at the initial assessment when compared to the final assessment for the study population. Visual motor skills in early development help children integrate information visually and provide appropriate motor responses. Visual motor skills are reflective of the child's emerging problem-solving skills and help the child interact with their environment. Blasi et al. (2007) found that deficits in perceptual reasoning correlated with the severity of cognitive impairment, which suggested that these two components may have a similar basis for information processing. Additionally, research has demonstrated that visual motor integration in kindergarten was predictive of skills obtained later in reading and math (Brock, Kim & Grissmer, 2018). Scores for visual motor skills for the study population indicated deficits which can impact subsequent cognitive and academic development. These findings highlight the importance of continued monitoring of development as well as the importance for early intervention to increase these skills.

The present study also hypothesized that the developing receptive and expressive language skills for study participants would be significantly below those of non-exposed peers. Outcomes indicated that a significant number of children were below the expected development for receptive and expressive language skills. Results also indicated that the number of children who were below development in these areas increased from the initial to the final assessment. When comparing language assessment results, more children were developmentally below for expressive language skills. These findings were consistent with outcomes demonstrated by research. Hall, McAllister, and Wexelblatt (2019) found that children born with NAS were significantly more likely than non-exposed peers to receive a diagnosis of speech disorder and developmental delay. Delays and deficits in receptive and expressive language have been indicated in subsequent learning difficulties (Balikci & Melekoglu, 2020). Receptive language refers to how language is understood; it is tied with verbal comprehension and phonological memory. Expressive language represents what the child can verbally express; these skills are often associated with vocabulary development and behavior. Continued deficits in these areas for the study population may indicate long-term outcomes for the skills necessary make gains in the school setting. Therefore, further monitoring and early intervention is implicated for children falling behind in language skill development.

The research team anticipated significance differences based upon the type of drug exposure; however statistical analysis did not support this hypothesis. Research has indicated that long-term adverse neurocognitive, behavioral, and developmental outcomes have been associated with prenatal opioid use. These outcomes became more apparent as development progressed through preschool and school age timeframes (Larson et al., 2019). The present study examined developmental outcomes from birth to 24 months. Therefore, it is possible that the type of drug exposure may become a more relevant variable as this population of children ages. It is also important to note that factors such as environment of care and the delivery of intervention services will continue to be relevant and create a complex picture of developmental outcomes.

The research team did not hypothesize that significant differences would be observed based upon diagnosis. The results indicated that scores for visual motor and language skill development were significantly lower for the IUDE only group. Hall, McAllister, and Wexelblatt (2019) studied developmental outcomes with a similar study population. Their findings indicated that children who were exposed to opioids prenatally were at an increased risk for developmental disorders, regardless of postnatal withdrawal severity. Therefore, it will be important to consider the needs of the child with prenatal drug exposure, even if they did not require medical intervention for withdrawal symptoms at birth. The research zeitgeist of recent years has focused on long-term outcomes associated with NAS. Future research and follow-up efforts will need to be inclusive of all populations with in utero drug exposure.

Limitations

The present study analyzed the developmental outcomes for 106 children that received routine follow-up treatment with Dayton Children's Hospital. This is only a small representation of the total number of children born with prenatal drug exposure in the area. The Ohio Hospital Association reported that between 2014-2018, there were 535 hospitalizations among Ohio newborn residents for NAS in Montgomery County, Ohio (2018a). Furthermore, there were 16,699 hospitalizations for infants with NAS across the state of Ohio during the same timeframe (Ohio Hospital Association, 2018b). Compared with these prevalence rates, the generalizability of findings for the study sample size is limited. The present study analyzed the data available from the children who received routine follow-up, but a control group of non-exposed peers was not included.

Additionally, there were concerns for the reliability and validity of The Capute Scales. The Mental Measurements Yearbook draws into question the strength of the reliability and validity of the standardization study. Information about the reliability and validity of the Rossetti Infant-Toddler Language Scales was not available from the publisher and is not widely discussed in current research literature. There were also difficulties in quantifying data to represent the developmental level for this criterion-referenced measure. For example, the research team was able to indicate whether a child was below, at, or above the expected development level for speech and language development. However, this study did not quantify the level of deficit observed. A child aged 10 months could have received an estimate of 3-6 months equivalent for language development, while another the same age could have received an estimate of 6-9 months. Both participants received equivalent “below” ratings, but the level of deficit was not indicated.

Data was analyzed in a time-series design for assessments for cognitive, motor, and language skills. Many of the study participants received a variety of therapeutic intervention services during the study timeframe. For example, an individual may receive speech, occupational therapy, and/or physical therapy services. However, the effects of these early intervention services were not measured by the present study. The researcher did not have reference to the training of the individuals administering the two different assessments given to the study population and will not be involved in determining reliability and validity measures related to test administration at Dayton Children's Hospital.

Implications for Practice

Recent research from Fucile, Gallant, and Patel (2021) indicated that while concerns for the cognitive, language, motor, and social developmental outcomes for children born with NAS have been indicated in research, results across the body of research have produced inconsistent outcomes. Variations in outcomes for the population of children with prenatal drug exposure is to be expected. With the present study, statistical analysis indicated that visual motor and language scores were significantly below expected outcomes. However, the level of deficit should further be considered. For example, many of the means and individual scores were within the low average to average range when considering a standard psychometric conversion table (Wrights Law, 2021). Therefore, it cannot be assumed that prenatal drug exposure automatically asserts impairments that warrant intensive intervention. Educators should be aware that this population is more at-risk when considering visual motor skills, however, there needs to be careful consideration of individual student need. As cognitive development continues for this population, norm-referenced assessments with high reliability and validity should be utilized to measure progress. Evaluation tools that measure the varied facets of cognition would further describe individual strengths and weaknesses.

The long-term impact of deficits in speech and language skills should be considered. Research has found that language skills were a predictor of subsequent emotional and behavior regulation skills (Roben, Cole, & Armstrong, 2013). Based upon observations from providers at DCH follow-up clinic, similar concerns emerge in practice with the study population. Therefore, early intervention strategies that target receptive and expressive language skills should be implemented for children who demonstrate deficits. Additionally, further consideration should be made for the language assessment of this population. A limitation of the present study indicated that the range of impairment could not be readily measured by the criterion referenced measure. It could be beneficial to include norm-referenced assessment for children that have demonstrated impairments in speech development to further define their needs, which can also guide intervention planning.

Further, there is a need to foster educator's understanding of the potential needs for this population of children, especially as they approach school-age. The need for collaboration between medical service providers and educational teams will become more evident to effectively anticipate individual needs, especially as the outcomes vary from child to child.

Future Research

As this population continues to grow and change, cognitive, adaptive, and language development grows more complex. Therefore, continuation of follow-up and assessment of needs are indicated across the span of development. In addition to the results discussed, statistical analysis was conducted to determine the relationship between scores and a host of variables including gender, race, environment of care, type of drug exposure along with interaction effects. While the results of these analyses were not statistically significant, these factors should be included in future studies. Further research was also indicated to determine the variables associated with the differences in outcomes based upon diagnosis in the present study.

Additionally, there were multiple sets of twins represented in the present study. Future research to compare the outcomes of children with the exact same type and timing of prenatal drug exposure should be considered. A good portion of the study population received therapeutic services in addition to routine follow-up. The impact of these therapeutic services would serve as a source of further research. Based upon observation from the developmental follow-up team, potential deficits in developmental areas including cognition, speech, and social are anticipated for children within this study population.

Dayton Children's Hospital has shifted to different measures for their follow-up for children in cognitive, language, and motor development. Further research to determine the long-term outcomes for children with prenatal drug exposure using these measures as well as the predictive value of scores obtained by the present study could be considered in future research.

Conclusion

Findings of the present study indicated that from birth to 24 months, children born with prenatal drug exposure were behind in visual motor and language skill development. These findings highlight the need for follow-up research to further explore the needs of children born with prenatal drug exposure. As children born with prenatal drug exposure approach school-age, educational teams should be prepared with accurate information of potential needs of this population along with a readiness to meet the variations present within the individual student.

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APPENDIX A

Medical Definitions

Developmental Area	Medical Term	Definition
Attentiveness	ADHD	A chronic condition including attention difficulty, hyperactivity, and impulsiveness.
	Hyperkinetic	A very common cause of children's behavior disorder disturbance is an entity described as the hyperkinetic impulse disorder. This is characterized by hyperactivity; short attention span and poor powers of concentration; irritability; impulsiveness; variability; and poor school work.
Speech & Language	Apraxia	Childhood apraxia of speech (CAS) is an uncommon speech disorder in which a child has difficulty making accurate movements when speaking. In CAS, the brain struggles to develop plans for speech movement.
	Articulation Disorder	A speech disorder involving difficulties in articulating specific types of sounds. Articulation disorders often involve substitution of one sound for another, slurring of speech, or indistinct speech.

	Mixed receptive-expressive language disorder	A communication disorder in which both receptive and expressive communication may be affected.
Vision	Exotropia	A form of strabismus where the eyes are deviated outward.
	Strabismus	A condition in which the eyes do not properly align with each other when looking at an object. The eye that is focused on an object can alternate. The condition may be present occasionally or constantly. If present during a large part of childhood, it may result in amblyopia or loss of depth perception.
	Nystagmus	A vision condition in which the eyes make repetitive, uncontrolled movements. These movements often result in reduced vision and depth perception and can affect balance and coordination. These involuntary eye movements can occur from side to side, up and down, or in a circular pattern.
Physical Development Deformity	Microcephalic	A condition where a baby's head is much smaller than expected. During pregnancy, a baby's head grows because the baby's brain grows. Microcephaly can occur because a baby's brain has not developed properly

		during pregnancy or has stopped growing after birth, which results in a smaller head size.
	Brachycephaly	A head shape condition where the head is wide in proportion to the length. It creates a flattened but symmetrical appearance in the back. Often the head appears vaulted or taller in the back.
	Craniosynostosis	A birth defect in which the bones in a baby's skull join together too early. This happens before the baby's brain is fully formed. As the baby's brain grows, the skull can become more misshapen.
	Macroencephaly	A condition in which the human head is abnormally large; this includes the scalp, the cranial bone, and the contents of the cranium.