SEASON-OF-BIRTH OF CHILDREN IN THE OTHER HEALTH IMPAIRMENT SPECIAL EDUCATION CATEGORY

by

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(Under the direction of ROY P. MARTIN)

ABSTRACT

The study examined the relationship between children's season-of-birth and their development of disorder(s) within the Other Health Impaired (OHI) special education category. This research builds on past studies that examined season-of-birth effects for schizophrenia, learning disabilities, mental retardation, and nervous system disorders. The sample consisted of 8, 602 students (between the ages of 6 and 18 years) in the OHI special education category from 44 of the most northern counties in Georgia.

It was postulated that the comparison of birth rates of children in the OHI special education category with birth rates of the general population would reveal that children in OHI are born at a disproportionate rate during the late spring and summer months (April to August). Chi square goodness of fit tests were used to compare the observed frequency of births per month for students in the OHI special education category with the expected frequency of births per month for students in the general population. Spectral analyses, a form of time series analysis, were utilized to determine if an annual cycle of births existed for children in the OHI special education category.

Consistent with the hypothesis, the peak birth period for children in the OHI special education category was during the late spring and summer months. Spectral analyses revealed that the disproportionate late spring and summer birth rate pattern for children in the OHI special education category occurred as an annual cycle each year during the period September, 1984 – August, 1995.

INDEX WORDS: Season-of-Birth, Other Health Impaired, ADHD, Seasonal variation, Birth pattern, Risk factor

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To the late Dr. Donald Henry Clanton

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CHAPTER 1

INTRODUCTION

Research involving the origin of psychopathology has generated worldwide debate and has been the subject of thousands of research articles. The majority of these research articles have concluded that human behavior is influenced by the interaction of the person's genes and environment. The central nervous system (CNS) is at the core of this interaction, and it is impacted by the individual's genetic heritage and exposure to contextual (environmental) circumstances.

When CNS functioning differs from its normal pattern, forms of dysfunctional behavior, such as psychopathology, may result. Damage to the CNS in the prenatal or perinatal environment can contribute to developmental anomalies in the CNS, which may lead to abnormal CNS functions. Morphological and biochemical mechanisms may be disrupted when the CNS structure is damaged during early stages of development.

The field of embryology has studied environmental risks to fetal development. Embryologists originally used the term teratogen to denote any prenatal disturbance causing the development of grossly abnormal or deformed offspring. This definition has been expanded in the research literature to refer to traumatic events or factors that initiate developmental problems of the nervous system that may lead to neurobehavioral disorders including psychopathology (Mayes & Ward, 2003).

The teratogenic effects upon development depend on the intensity (physical force, radiation dose, maternal blood alcohol level, etc.), duration (repeated, persistent, momentary, etc.), form of insult (toxin, mechanical trauma, malnutrition, etc.), and time of incidence during the developmental process (Mayes & Ward, 2003). The effects of the teratogen insult may be manifested in death of the organism, gross malformation of CNS structures, or less serious consequences, such as mental retardation. Prenatal development is thought to be mostly genetically determined, and it is primarily fixated on the structural formation of the CNS (Anderson, Northam, Hendy, & Wrennall, 2001). Developmental interruptions during the prenatal period, via intrauterine trauma or infection, for example, are likely to have a substantial impact on cerebral structure, so that morphology of the brain appears abnormal even at a macroscopic level (Anderson et al., 2001). The outcomes of high intensity, long duration teratogen exposure are easily observed and related to the source of the exposure. Lower intensity or shorter duration exposure to teratogens may yield subtle more difficult to detect effects.

There is not yet a clear understanding of the range of factors that adversely alter prenatal CNS development and result in future psychopathology. This research literature is significantly less well-developed than the literature on postnatal influences. Anderson et al. (2001) have concluded, however, that the vulnerability of the organism during its prenatal development is greater than after birth.

The CNS is most susceptible to deleterious effects of trauma or exposure to environmental variables (e.g. malnutrition, radiation, toxins, etc.) during certain critical periods of development. These critical periods are most often the periods of most rapid development. Researchers have discovered that the timing of an insult to the central nervous system is a major factor in determining the type and degree of any resultant altering of neural development (Mayes & Ward, 2003). Because of very rapid growth during the prenatal period, this period seems to be a period of particular vulnerability.

Some environmental variables that can result in prenatal damage are more prevalent at different times of the year. Environmental variables such as weather, diet, insect-borne illnesses, upper respiratory infections, and photoperiods vary with the seasons. These annual cyclical patterns offer the opportunity to discover fluctuations in the influence of these factors on overall development. Studies examining annual cyclical patterns of environmental variables and their influence on development have formed a body of research literature sometimes referred to as season-of-birth research (Pasamanick & Knobloch, 1958; Dalen, 1975).

Season-of-birth studies typically examine how annually occurring environmental factors adversely affect prenatal development particularly of the central nervous system. For example, maternal viral infections, occurring more frequently during the winter months, can have detrimental impacts on the developing central nervous system of the fetus. Thus, these viral infections could be linked to later psychopathology (Mick, Biederman, & Faraone, 1996). For example, measles and cytomegalovirus infections, capable of causing fetal damage, have a seasonal incidence. A variety of disorders have been linked to seasonal birth patterns including schizophrenia, autism, dyslexia or reading disorder, glaucoma, allergic sensitization, asthma, allergic rhinitis, and menstrual disorders (Castrogiovanni, Iapichino, Pacchierotti, & Pieraccini, 1998). The relationship between season-of-birth and the risk for psychopathology has been examined in dozens of countries, and researchers have now contributed over 250 published studies considering this association, particularly as it relates to schizophrenia (Castrogiovanni et al., 1998).

Purpose

The proposed study will build on the season-of-birth literature by examining a potential link between season-of-birth and occurrence of disorders in the Other Health Impaired (OHI) special education category. This research is intended to determine if there are associations between the period during the year that a child is born and whether or not a child was given the diagnosis of a disorder included in the Other Health Impaired special education category. A large sample of elementary, middle, and high school students with Other Health Impaired special educational placement in forty-four of the most northern counties in Georgia forms the pool of research participants. Other Health Impaired is a special education category that includes Attention-Deficit/Hyperactivity Disorder (ADHD) and a wide variety of somatic illnesses that affect the education of children (e.g. diabetes). Several school districts have estimated that up to 90 % of their students in OHI in Georgia have the diagnoses of ADHD. These analyses will examine monthly birth distributions for children in the OHI special education category, and compare these distributions to the population birth rates per month for the State of Georgia. In addition, trend analyses will attempt to determine if a pattern of OHI births exist in seasons of the year during a ten-year period. It is hypothesized that birthrates for children in the OHI special education category will be disproportionally higher in the spring and summer than population birth rates. The sizable majority of students in the Other Health Impaired category have ADHD, and it is assumed that children and adolescents with ADHD will comprise most of the disproportionate spring and summer birth rate of the children and adolescents in the Other Health Impaired category when compared with the general population birth rate. Questions that stem from this hypothesis include: 1) Will the birthrates per month for children in the OHI special education category be similar across different ethnic groups (Caucasian, African-American etc.)? 2) Will a greater percentage of boys in the OHI special education category than girls in the OHI special education category be born during the spring and summer months? 3) Is the pattern of births of students in the OHI special education category different in urban than in rural environments? 4) Is the pattern of births of students in the OHI special education category consistent during a ten-year period studied?

CHAPTER 2

REVIEW OF THE LITERATURE

Special Education Categories

A federal law, the Individuals with Disabilities in Education Act (IDEA), governs most special education services for children in school systems in the United States. The following thirteen categories of special services are included in the IDEA federal special education regulations: Autism, Deaf-Blindness, Deafness, Emotional Disturbance, Hearing Impairments, Mental Retardation, Multiple Disabilities, Orthopedic Impairment, Other Health Impairment, Specific Learning Disabilities, Speech or Language Impairment, Traumatic Brain Injury, and Visual Impairment. Attention-Deficit/Hyperactivity Disorder (ADHD) is included in the Other Health Impairment (OHI) special education category.

The Federal Department of Special Education defines OHI in the IDEA federal special education regulations as:

> *Other health impairment* means having limited strength, vitality or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that—(i) Is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder, diabetes, epilepsy, a heart condition, hemophilia, lead poisoning, leukemia, nephritis,

rheumatic fever, and sickle cell anemia; and (ii) Adversely affect

a child's educational performance (Grice, 2002).

In order to qualify as eligible for the OHI special education category a child must meet four conditions (Grice, 2002). First, he or she must be negatively impacted by a chronic or acute health condition (Grice, 2002). Second, the health condition must cause limited alertness to the educational environment due to limited strength, vitality, or alertness or heightened alertness to the surrounding environment (Grice, 2002). Third, the child's educational performance must be adversely affected by the disability (Grice, 2002). Finally, OHI must create a need for special education services (Grice, 2002). .

There are many types of diseases that are included in the OHI special education category. The most common are ADHD, asthma, diabetes, and epilepsy. The educational implications of asthma, diabetes, and epilepsy will be reviewed first. The remainder of the chapter will focus on ADHD as the diagnosis is present in 80 to 90 percent of children in the OHI service category.

Asthma

Asthma is a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role (Koppelman, Meijer, & Postma, 1999). In individuals who are susceptible to asthma, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning (Koppelman et al., 1999). These episodes are normally associated with widespread but variable air flow obstruction that is often reversible either spontaneously or with treatment (Koppelman et al., 1999). This inflammation also causes an associated increase in existing bronchial responsiveness to a variety of stimuli (Koppelman et al., 1999).

In a study conducted by Rhodes, Moorman, and Redd (2005), they discovered that the lifetime prevalence estimate for acquiring asthma in eight states (Indiana, Iowa, Michigan, Mississippi, Missouri, Pennsylvania, South Dakota, and Washington) was 11.2 % (n = 31,618). This estimate was similar to an overall estimate (11.0 %) for the United States (50 states and the District of Columbia) (Rhodes et al., 2005).

A similar prevalence rate for asthma was found in a study that examined Georgia children. A random-digit-dial telephone survey of 1503 households with 2700 children was conducted in Georgia. Primary caretakers were interviewed, and results for households, children, and caretakers were weighted by number of telephone lines (Mellinger-Birdsong, Powell, Iatridis, & Bason, 2003). Results for children were also weighted to the Georgia 1998 estimated population (Mellinger-Birdsong et al., 2003). The results indicated that asthma prevalence among children in Georgia aged 0 to 17 years was 10.5% (95% confidence interval [CI] = 9.2% – 11.9%) (Mellinger-Birdsong et al., 2003).

The exact cause of asthma acquisition is unknown at this time. Asthma etiology is complex, and it most likely involves interactions between genetic susceptibility, allergen exposure and external aggravating factors such as air pollution, smoking, and respiratory tract infections (Esposito & Principi, 2001). Many epidemiological studies have highlighted that most episodes of asthma exacerbation occurring in early life are associated with respiratory infections, the most frequently encountered agents being respiratory syncytial virus, adenovirus, parainfluenza viruses 1, 2, and 3, influenza viruses type A and B, and rhinovirus serotypes 16 and 19 (Esposito & Principi, 2001). It is likely that if viral respiratory infections can trigger the 'asthmatic process' this will occur only in individuals who are predisposed either by their genetic background or by events which have 'primed' their immune system and lungs (Esposito & Principi, 2001).

Chlamydia pneumoniae and *Mycoplasma pneumoniae* are the causative agents in a number of respiratory diseases, including upper respiratory tract illnesses such as rhinitis, pharyngitis or otitis, as well as bronchitis and atypical pneumonia (Esposito & Principi, 2001). Recently, these pathogens have also been linked with possible initiation and promotion of asthma (Esposito & Principi, 2001). *C. pneumonia* and *M. pneumoniae* are plausible etiological agents in asthma because of their affinity for the human respiratory tract and their demonstrated ability to produce chronic respiratory tract infection and inflammation (Esposito & Principi, 2001).

It is conceivable that children with asthma might be at risk for decreased school functioning due to acute exacerbations of this disease, increased absenteeism secondary to symptoms, iatrogenic effects of students' asthma medication (e.g. oral steroids), poor medical management of the disease, and/or stress associated with having a chronic illness (Taras & Potts-Detema, 2005). Almost two-thirds of the published studies that address school performance and students with asthma demonstrate no difference in levels of academic achievement or ability (Taras & Potts-Detema, 2005). Of the nearly one-third of children with asthma who manifested a difference in educational performance, the difference was limited to students with severe and persistent symptoms or to other contributing social factors such as income (Gutstadt, Gillette, Mrazek, Fukuhara, LaBreoque, & Strunk, 1989).

Diabetes

On a typical week day, children spend one-third of their day in school, thus school personnel play a crucial role in the daily care of children with diabetes. Children and adolescents with diabetes must achieve the same level of diabetes management at school as they do other places (Barrett, Goodwin, & Kendrick, 2002). Students often have to incorporate glucose monitoring, insulin injections, and meal plans into their school routines (Siminerio & Koerbel, 1999).

The prevalence of diagnosed diabetes in the United States increased 33 % between 1990 and 1998. This increase was evident across all ages, races, educational levels, and weight levels. There was a 70 % increase in diagnosed diabetes among individuals aged 30-39 years. There were also significant increases among Hispanics (38 % increase), Caucasians (29 % increase), and African-Americans (26 % increase).

Approximately 15.7 million people in the United States have diabetes (National Diabetes Awareness Month, 1997). Of these, 1.5 million are children and adolescents (Glaser, 1997). Among these young people, approximately 70%-85% have Type 1 diabetes (previously called insulin dependent diabetes mellitus, juvenile diabetes) and up to 30% have Type 2 diabetes (previously called non-insulin dependent diabetes mellitus, adult-onset diabetes), primarily due to the increase in childhood obesity (Glaser, 1997). While the number of children with Type 2 is increasing significantly, this description will focus primarily on Type 1.

It is well established that in type I diabetes the major etiologic process involves autoimmune destruction of the insulin-secreting pancreatic beta cells (McCarthy & Menzel, 2001). The etiological picture is not as clear for type II diabetes. There is a connection between type II diabetes and obesity, and the clustering of type II diabetes, hypertension, dyslipidaemia, and macrovascular disease within individuals and families, indicates that reduced sensitivity to the peripheral actions of insulin (i.e. insulin resistance) plays a key role in the disease (McCarthy & Menzel, 2001).

However, since many individuals with strong levels of insulin resistance still manage to maintain normal glucose levels, variation in the compensatory capacity of the pancreatic beta-cell must be an equal partner in the progression of the disease (McCarthy & Menzel, 2001).

A study conducted by McCarthy, Lindgren, Mengeling, Tsalikian, and Engvall (2003) concentrated on the effects of diabetes on learning in children. The study concluded that, for most children, type-1 diabetes is not associated with lower academic performance, compared with either siblings or classmates, although parents report increased behavioral concerns (McCarthy et al., 2003). However, careful monitoring is still required to ensure that episodes of hypoglycemia associated with seizures do not adversely affect learning (McCarthy et al., 2003).

In a study by Kaufman, Epport, Engilman, and Halvorson (1999), children were assessed for their cognitive skills, academic achievement in reading, mathematics, and written language, as well as for speech articulation and motor coordination. No significant difference between the diabetes mellitus group and the control group was found in cognitive skills. They also found that the age of the diagnosis and the duration of the diabetes did not relate to neurocognitive test results. There was no association between neurocognitive test scores with severe hypoglycemia; nevertheless, subjects with a history of hypoglycemic seizures had a decrease in test scores assessing memory skills (Kaufman et al., 1999).

Epilepsy

Fisher and colleagues recommended the following definition of epilepsy: "Epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures and by the neurobiologic, cognitive, psychological, and social consequences of this condition" (Beghi, Berg, Carpio, Forsgren, Hesdorffer, Malmgren, Shinnar, Temkin, Thurman, & Tomson, 2005). Fisher's definition requires the occurrence of at least one epileptic seizure but not that the seizure by unprovoked (Beghi et al., 2005). Although it may be helpful to regard diverse conditions (febrile seizure, acute symptomatic seizure, single unprovoked seizure, and epilepsy) within the context of studying the seizure disorders, it is not helpful to consider all of these conditions as epilepsy (Beghi et al., 2005).

The onset of epilepsy occurs most frequently in the earliest years of life, decreases in adolescents, remains relatively stable in the middle years, and then increases for those aged 60 years and older (Holden, Nguyen, Grossman, Robinson, Nelson, Gunter, Worley, & Thurman, 2005). Epilepsy patients of all ages have an elevated standardized mortality rate 2 to 3 times higher than that of the general population (Holden et al., 2005).

Experts estimate that 2.5 million people are being treated for epilepsy in the United States (Holden et al., 2005). Each year, 150,000 people receive a new diagnosis of epilepsy, and many more cases remain undetected (Holden et al., 2005). Most studies conducted in developed countries indicate wide variability in the prevalence of epilepsy, ranging from four to 10 cases per 1,000 persons (Holden et al., 2005). The actual rate may be much higher, however, because only half of patients with epilepsy are diagnosed within the first 6 months of the disorder (Holden et al., 2005). Epilepsy is the most common childhood neurological condition, affecting between 4 and 10 children per 1, 000 generally (Hauser & Hersdorffer, 1990) and between 4 and 5 per 1,000 children during the elementary school years (Tidman, Saravanan, & Gibbs, 2003; Waaler, Blom, Skeidsvoll, & Mykletun, 2000).

Epileptic syndromes can be of unknown cause (idiopathic) or can result from underlying brain damage or disease (Rados, 2005). Anything that disturbs the usual pattern of neuron activity—illness, brain damage, or abnormal brain development – can lead to seizures (Rados, 2005). According to the National Institute of Neurological Disorders and Stroke (NINDS), research has shown that the cell membrane surrounding each neuron plays an important role in epilepsy (Rados, 2005). Cell membranes are crucial for a neuron to generate electrical impulses (Rados, 2005). For this reason, researchers are studying details of the membrane structure, how molecules move in and out of membranes, and how the cell nourishes and repairs the membrane (Rados, 2005). A disruption in any of these processes may lead to epilepsy. In some cases, the brain's attempts to repair itself after a head injury, stroke, or other problem may generate abnormal nerve connections that lead to epilepsy (Rados, 2005).

There have been some suggestions that seizures during early development are worse in regard to cognitive impairment than are those occurring in the mature brain (Huttenlocher & Hapke, 1990). Some children with epilepsy experience some degree of educational difficulty. The distributions of IQ scores is lower among children with epilepsy than for the general child population (Bailet & Turk, 2000), and children with epilepsy as an entire group are at an increased risk for mental retardation (Singhi, Bansal, Singhi, & Pershadi, 1992). Children with special needs are 30 times more likely to have epilepsy than their regular education classmates (Tidman et al., 2003). Compared to children with other chronic illnesses (e.g. asthma), children with epilepsy experience more social, interpersonal, emotional, behavioral, and school adaptation problems, as well as lower academic achievement (Austin, Huberty, Huster, & Dunn, 1998; Austin, Smith, Risinger, & McNelis, 1994; Bailet & Turk; Davies, Heyman, & Goodman, 2003; Dunn & Austin, 1999; Huberty, Austin, Huster, & Dunn, 2000). Even when the distribution of IQ with low IQ's are excluded, children with well-controlled idiopathic epilepsy demonstrate lower reading and spelling scores and poorer motor and memory performance than their healthy siblings (Wodrich, Kaplan, & Deering, 2006).

Attention-Deficit/Hyperactivity Disorder

Children diagnosed with ADHD often suffer from low self-esteem and poor academic self-image, especially those children who are diagnosed during elementary school. If their problems with ADHD symptoms are not addressed appropriately at a young age, these children are more likely to experience school failure (Hechtman, 1999). Ineffectively treated ADHD has long-term and far-reaching consequences including poor educational adjustment and a host of related social problems including school dropout (National Institutes of Health Consensus Development Panel, 2000).

ADHD is a neurodevelopmental disorder that manifests itself as developmentally inappropriate symptoms of hyperactivity, impulsivity, and inattention. The onset of ADHD symptoms is often in the preschool years, typically at 3 to 4 years, and, more generally, before age seven (Taylor, Sandberg, Thorley, & Giles, 1991). ADHD pervasively affects the individual across the lifespan, and 50 percent or more of children with ADHD continue to have the disorder into adulthood (Barkley, 1996). The constructs of inattention, hyperactivity, and impulsivity are clearly defined when one considers them globally, but are more elusive when situational variability is considered. Experimental literature has highlighted the lack of precise operational definitions for these constructs, with inattention and impulsivity appearing the most vague (Schaughency & Hynd, 1989).

Inattention often manifests itself in a child’s inability to sustain attention, being more distracted by irrelevant stimuli, more disorganized, and forgetful than peers of the same age (Barkley, 1996). Teachers and parents often complain that children with inattention problems are less persistent with tasks or play activities, tend to daydream, do not seem to listen, fail to finish assignments, and have difficulty concentrating (Barkley, 1996). Children and adolescents with inattention difficulties may make careless errors in schoolwork or other tasks, and they may fail to closely attend to details (American Psychiatric Association, [APA] 1994). Often they will turn in messy work and they have the appearance of their “minds being elsewhere” (APA, 1994). In addition, when an activity is interrupted for a child or adolescent with attention difficulties, they are more likely to be slower and less likely to return to the activity (Barkley, 1996). Problems with inattention tend to become apparent between five and seven years of age, or by formal schooling entry if only attention problems are the principal difficulty (Hart, Lahey, Loeber, Applegate, Green, & Frick, (in press); Loeber, Green, Lahey, Christ, & Frick, 1992). Attention difficulties are persistent and relatively stable during the elementary grades, but they tend to decrease by adolescence (Fischer, Barkley, Fletcher, & Smallish, 1993a).

Children who are hyperactive often fidget or squirm in their seat and they do not remain seated when expected to do so (APA, 1994). These children often appear as if they were “driven by a motor,” and they seem like they are “on the go” (APA, 1994). Inappropriate and excessive running or climbing, excessive talking, and difficulty participating or engaging in quite leisure activities all represent characteristic features of hyperactive children (APA, 1994).

Hyperactivity may appear in different sets of behaviors depending on the individual’s age and developmental level (APA, 1994). Research has demonstrated that symptoms of hyperactivity arise first at age three to four years (Barkley, 1996). Toddlers and preschoolers tend to display hyperactive behaviors more frequently and with greater intensity than school-age children (APA, 1994). Adolescents and adults reveal hyperactive symptoms by having feelings of restlessness, and they have significant difficulty engaging in sedentary and quiet activities (APA, 1994).

Impulsivity has been classified as a dimension of personality, defined as failure to resist a drive, an impulse, or temptation that is harmful to oneself or others (Hollander & Evers, 2001). The manifestation of impulsivity is exhibited by children’s difficulty in delaying responses, blurting out answers before questions have been completed, and impatience (APA, 1994). Additionally, children and adolescents that have problems with impulsivity have difficulty awaiting their turn, frequently interrupt or intrude on others to the point of initiating difficulties in social, academic, or occupational settings, touch things they are not supposed to touch, and they fail to listen to directions (APA, 1994). Older adolescents may potentially engage in dangerous activities without consideration of possible consequences (e.g., using illegal drugs) (APA, 1994). Children with ADHD typically display behavioral impulsivity, which implies a global disinhibition of behavior (Hinshaw, 1994). The impulsivity symptoms in ADHD have been characterized as dysregulated motor activity (Hinshaw, 1994).

Children and adolescents who have difficulty with impulsivity are less able to delay gratification and resist immediate temptations (Anderson, Hinshaw, & Simmel, 1994; Campbell, Szumowski, Ewing, Gluck, & Breaux, 1982; Rapport, Tucker, Dupaul, Merlo, & Stoner, 1986, as cited in Barkley, 1996). For typically developing children, symptoms of impulsivity begin to manifest themselves around three to four years of age. These impulsivity symptoms tend to decline with age.

ADHD has been one of the most heavily researched childhood disorders. Although there are an abundance of research studies on ADHD, there are a limited number of follow-up studies concerning the effects or influence of ADHD across an individual's lifespan (Barkley, 1996). Even so, researchers and clinicians can say more about the outcomes of children with ADHD than they can about most other mental disorders that have their genesis in childhood.

The influence of ADHD is likely to be felt in areas of social, academic, familial, and emotional domains of adjustment. Problems in these domains will lead them to often experience punishments, harsh judgments, social rejection and ostracism, and moral denigration reserved for those society views as unmotivated, lazy, selfish, immature, thoughtless and irresponsible (Barkley, 1996).

In the social domain, children with ADHD are more likely to be negative and defiant, less able to work and play independently of their mothers, less compliant and cooperative, more demanding of assistance from others, and more talkative (Barkley, 1996). Academically, children or adolescents with ADHD encounter a wide array of difficulties. “It is not surprising, then, that as many as 40% of children with ADHD have received some form of special educational assistance by adolescence, with 25% to 35% or more having been retained in grade at least once, 10% to 25% having been expelled, and between 10% and 35% never completing high school” (Fischer, Barkley, Edelbrock, & Smallish, 1990; Weiss & Hechtman, 1993).

Negative parent-child interaction patterns are common in families that have a child or adolescent with ADHD. Mothers of children and adolescents with ADHD often give more rewards and commands to their ADHD sons than to their daughters (Barkley, 1996). In addition, mothers of children and adolescents with ADHD tend to be more acrimonious and emotional in their interactions with their sons with ADHD (Barkley, 1996). As the children grow older, the degree of conflict in these interactions decreases but remains deviant from normal into later childhood (Barkley, Karlsson, & Pollard, 1985; Mash & Johnston, 1982) and adolescence (Barkley, Anastopolous, Guevremont, & Fletcher, 1992; Barkley, Fischer, Edelbrock, & Smallish, 1991).

The stability of ADHD throughout childhood, adolescence, and adulthood varies based on comorbid conditions and specific symptoms of the disorder. ADHD symptoms persist through childhood into early adolescence, and appear to be associated with the coexistence of oppositional hostile behavior or conduct problems, conflict in parent-child interactions and poor family relations, maternal depression, the initial degree of hyperactive-impulsive behavior in childhood, and duration of mental health interventions (Fischer, Barkley, Fletcher, & Smallish, 1993b; Taylor et al., 1991).

ADHD is classified into three subtypes in the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV) based on the constellation of inattentive, hyperactive, and impulsive symptoms (ADHD- Predominately Inattentive; ADHD-Predominately Hyperactive-Impulsive; ADHD-Combined) (APA, 1994). In order for the disorder to be diagnosed, some impairment from the symptoms of the disorder must be present in two or more settings (at school, work, or at home) (APA, 1994). Diagnosticians consider other psychiatric disorders when working with individuals with ADHD, because ADHD is often comorbid with other psychiatric disorders. ADHD manifests comorbidity with the externalizing domain (e.g., conduct disorder and oppositional defiant disorder) and the internalizing domain (depression and anxiety disorders) (Biederman, Faraone, Keenan, & Tsuang, 1991), along with cognitive comorbidity (learning disabilities).

Section 504 of the Rehabilitation Act of 1973 (Section 504) and the Individuals with Disabilities Education Act (IDEA) guarantee children with Attention-Deficit/Hyperactivity Disorder (ADHD) a free and appropriate public education (FAPE) (Children and Adults with Attention-Deficit/Hyperactivity Disorder (CHADD), 2000). Both laws also mandate that children with disabilities be educated to the maximum extent appropriate with children who do not have disabilities. The most significant difference between these two laws is that eligibility for IDEA requires that a child have a disability requiring special education services, while Section 504 eligibility may occur when the child needs special education or related services (CHADD, 2000). Children covered under Section 504 typically either have less severe disabilities than those covered under

IDEA, or have disabilities that do not neatly fit within the eligibility categories under IDEA (CHADD, 2000).

In 1990, the U.S. Department of Education was ordered by Congress to conduct a "Notice of Inquiry" to solicit public comments about how schools throughout the country were serving children with ADHD (CHADD, 2000). The U.S. Department of Education issued a "Policy Clarification Memorandum" on September 16, 1991. This memorandum explicitly stated that children with ADHD might qualify for special education and related services solely on the basis of their ADHD when it significantly impairs educational performance or learning (CHADD, 2000). The memorandum recognized children with ADHD as potentially eligible for both Section 504 and IDEA services when the ADHD causes such impairment (CHADD, 2000). ADHD was formally listed in the IDEA Regulations under the category of Other Health Impairment (OHI) on March 11, 1999. The ADHD may be chronic (long-lasting) or acute (have a substantial impact); this must result in an adverse effect on educational performance; must result in limited alertness to academic tasks, due to heightened alertness to environmental stimuli; and the student must require special education services in order to address the ADHD and its impact (CHADD, 2000). Schools are required to address the impact of a child's disability in all areas of functioning, including academic, cognitive, social-emotional, communication, vocational and independent living skills (CHADD, 2000).

ADHD affects from 3% to 7% of school-age children (APA, 1994). The prevalence rates of ADHD vary and are largely dependent on the population sampled (ethnicity, urban vs. rural, etc.), the method of selecting subjects (elevated cutoff scores vs. agreement between parents, teachers, and physicians on rating scales), and the age range of the samples (APA, 1994 & Barkley, 1996). When strict criteria are applied to severe developmentally inappropriate levels of inattention, impulsivity, and overactivity with criteria confirmed by two sources to produce school and home impairment, the prevalence is approximately 3 % of the school-aged population (Barr, Swanson, & Kennedy, 2001). During the six to twelve-year-old age period, prevalence rates may be six to nine percent in boys and two to three percent in girls (Szatmari, Offord, & Boyle, 1989). In adolescence, the prevalence rates may fall to three to five percent in boys and one to two percent in girls (Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993; Barkley, 1996; McGee, Feehan, Williams, Partridge, Silva, & Kelly, 1990; Szatmari et al., 1989). On average, male children are three times more likely than female children to be diagnosed as having ADHD within epidemiological samples (Lewinsohn et al., 1993; McGee et al., 1990; Szatmari, 1992).

Numerous theories have been postulated on etiological explanations of ADHD. Indirect evidence has been mounting that ADHD develops from abnormalities in brain development. Some leaders in the field believe that these abnormalities are related more to hereditary factors than to environmental ones (Barkley, 2000). Minor physical anomalies (e.g. ears, face) as well as learning disabilities have been found in children with ADHD suggesting some congenital neurodevelopmental abnormality is associated with ADHD.

Some environmental factors have been closely linked to ADHD symptoms and behaviors. For example, animal studies have demonstrated conclusively that alcohol and nicotine cause abnormal development of certain brain regions, and that these abnormalities in brain regions lead to increased hyperactive, impulsive, and inattentive behavior (Barkley, 2000). In numerous studies, animals exposed in utero to alcohol had altered reflex development and motor functioning, demonstrated feeding difficulties, hyperactivity and attention deficits, and impaired learning, including poorer associative and passive avoidance learning (Weinberg, 1997). Researchers have discovered that nicotine, ethanol and its metabolites, and caffeine, as well as stress hormones, pass through the placental barrier and reach the human fetal brain (Linnet, Dalsgaard, Obel, Wisborg, Henriksen, Rodriguez, Kotimaa, Moilanen, Thomsen, Olsen, & Jarvelin, 2003). Reich, Earls, Frankel, and Shayka (1993) found a strong association between parental alcoholism and oppositional/conduct disorders in children. In addition, significantly higher rates of overanxious disorder on both the research and the clinical diagnoses were found in children of alcoholic parents. The heavier the prenatal exposure (and/or the more detrimental the timing and pattern of alcohol exposure), the greater the developmental impact and the more likely that structural and physical problems will take place along with function difficulties (Vorhees & Mollnow, 1987; as cited in Carmichael Olson, Streissguth, Sampson, Barr, Bookstein, & Thiede, 1997).

An example of the increased developmental impact with heavier prenatal alcohol exposure involves fetal alcohol syndrome (FAS). Young children with fetal alcohol syndrome show increased rates of problems such as mental retardation, poor coordination, and attentional deficits (Committee on Substance Abuse and Committee on Children With Disabilities, 1993; as cited in Carmichael-Olson et al., 1997). Steinhausen, Willms, and Spohr (1993) studied the long-term outcomes of a large cohort of children suffering from fetal alcohol syndrome. These researchers found that almost two-thirds of these children had at least one psychiatric syndrome (Steinhausen et al., 1993).

Hyperkinetic disorders (ADHD), emotional disorders, stereotypies, speech disorders, and eating disorders of childhood were the predominant disorders suffered by this cohort of children.

Coles (2001) conducted a study of fetal alcohol exposure and attention. The sample consisted of 25 children who had either FAS or fetal alcohol effects (FAE), 62 alcohol-exposed children who were not affected, and a control group of 35 children who had not been exposed to alcohol during pregnancy. To examine the association with ADHD, 27 ADHD-diagnosed children were selected from the child psychiatry clinic at the same hospital where the other children were born (Coles, 2001). The children with ADHD had the most difficulty on measures of focused and sustained attention (Coles, 2001). The children in the FAS-FAE group performed the poorest on measures of encoding and shifting attention. In addition, children in the ADHD group had difficulty with selective and sustained attention, and they were more impulsive (Coles, 2001). In contrast, the children in the FAS-FAE group were not identified as having significant behavior problems, and they were not impulsive (Coles, 2001). Coles concluded that these results call into question assumptions that behavior seen in children with FAS results from the same neurocognitive deficits as seen in children with ADHD.

Timing and dosage effects of alcohol exposure were studied by Carmichael-Olson et al. (1997). They discovered that prenatal drinking patterns linked with the highest risk to the offspring are those in which binge drinking occurs and in which drinking occurs earlier in pregnancy. Alcohol-related decrements in childhood include attention, response inhibition, and different types of learning and memory (e.g., Brown, Coles, & Smith, 1991; as cited in Carmichael-Olson et al., 1997). Additionally, a consistent correlation between high levels of lead exposure and symptoms of inattention or hyperactivity, or even some cases of full-fledged ADHD has been discovered by researchers (Barkley, 2000).

Prenatal exposure to nicotine may lead to faulty regulation in neurodevelopment and can indicate increased risk for psychiatric problems (Ernst, Moolchan, & Robinson, 2001). The cognitive and behavioral deficits linked with in utero exposure to tobacco seem to proliferate into late childhood and adolescence and lead to greater risk for ADHD and conduct disorder (CD) (Ernst et al., 2001). Prenatal exposure to nicotine is known to disrupt some important neurotransmitter systems.

The development of the catecholaminergic system is disrupted when individuals are prenatally exposed to nicotine and this may explain the increased incidence of ADHD, given the role of catecholamines (dopamine, norepinephrine, and epinephrine) in this disorder (Schweitzer, Anderson, & Ernst, 2000; as cited in Ernst et al., 2001). It has been hypothesized that there is a decrease in dopamine and norepinephrine levels in the prefrontal cortex region of the brains of children and adolescents with ADHD, and the deficit of these neurotransmitters produces the symptoms of ADHD in these children and adolescents. Dopamine is responsible for mediating reward and reinforcement behavior through the mesocorticolimbic pathway. It has been suggested that dopamine plays a role in connecting motor activity, emotion, attention, and impulse control since dopamine neurons are present in the brain regions that control these activities (Hallowell & Ratey, 1994). The primary behavioral effect of the activation of norepinephrine neurons is an increase in vigilance or attentiveness to environmental events (Carlson, 2004).

Animal study results indicate that offspring hyperactivity may result from prenatal nicotine exposure and these effects are long-lasting (Linnet et al., 2003). Studies on humans have produced an association between maternal smoking during pregnancy and preterm delivery, stillbirth, and low birth weight (Linnet et al., 2003).

Maternal stress during pregnancy and caffeine intake during pregnancy are two other hypotheses that have been explored into the etiology of ADHD. Only one study looked into the possibility that in utero caffeine exposure could affect child behavior, and the scarcity of unexposed children hindered the interpretation of the results (Linnet et al., 2003). Studies that examined maternal stress during pregnancy demonstrated a small but statistically significant association with disruptions in attention and activity (Linnet et al., 2003).

Some of the potential biological theories regarding the etiology of ADHD include the following: injury to the *orbital-frontal region* of the brain, genetic predisposition to the disorder, lack of dopamine and norepinephrine neurotransmitters, less blood flow to the striatum region of the caudate nucleus, less electrical activity in the frontal area of the brain, lowered brain activity on PET Scans in the frontal area of the brain, and structurally smaller brain regions (right prefrontal cortex, basal ganglia, and right cerebellum) (Barkley, 2000).

Neurotransmitter system functioning has received some attention. Dysregulation of the serotoninergic system and a presynaptic deficit of available serotonin have been observed in humans with impulsive disorders, as well as animal models of aggression and impulsivity (Hollander & Evers, 2001). Dopamine system functioning, particularly within the mesocorticolimbic pathways, is crucial in the mediation of reward and reinforcement behaviors (Hollander & Evers, 2001). Gene association studies related to dopamine receptors have yielded support to a genetic influence in impulsive behaviors, and μ-opioid receptors are involved in the regulation of these pathways (Hollander & Evers, 2001).

Of the potential biological theories into the etiology of ADHD, the genetic predisposition theory has been given the most attention because it encompasses the other biological theories. The altered brain chemistry, brain underactivity, and smaller brain regions could all possibly be explained by a genetic predisposition to have ADHD (Barkley, 2000). Studies that have focused on the heritability of ADHD have either been family, twin, or adoption studies. Evidence from multiple family, twin, and adoption studies supports an important etiological role for genes in the expression of ADHD and its associated behaviors, although the mode of inheritance for ADHD remains unspecified (see review by Lombroso, Pauls, & Leckman, 1994, as cited in Sherman, Iacono, & McGue, 1997). Barkley (2000) reviews the literature on the role of genes in the etiology of ADHD and finds that the average heritability for symptoms of ADHD is .80 (range .50 - .90).

Twenty potential candidate genes for the etiology of ADHD have been researched. Faraone and his colleagues conducted a meta-analysis of one of these potential causal genes, the association between the 7-repeat allele of the Dopamine D4 Receptor Gene and ADHD (Faraone, Doyle, Mick, & Biederman, 2001). Researchers have discovered that ADHD is a complex, multifactorial disorder, thus the small magnitude of association between the DRD4 gene and ADHD fits with earlier research about the genetics of ADHD (Faraone et al., 2001). This suggests that other genes may work in concert with DRD4 to cause ADHD (Faraone et al., 2001).

The neurocircuitry of impulsivity has been examined by Cardinal and colleagues. Lesions to the nucleus accumbens core (AcbC), the brain region that helps determine reward and reinforcement, stimulated persistent impulsive choices in rats (Cardinal, Pennicott, Sugathapala, Robbins, & Everitt, 2001). The rats consistently preferred small or poor rewards that were immediately available to larger delayed rewards (Hollander & Evers, 2001). Locomotor hyperactivity was also displayed by these animals. This is another indicator of the hyperactive-impulsive subtype of ADHD, thus lesions in the AcbC in rats may represent an animal model of ADHD (Hollander & Evers, 2001). In addition, lesions to the amygdala have been associated with a complex formulation of aggressive and impulsive behaviors and impaired decision making skills (Hollander & Evers, 2001). Taken together, aspects of the research indicate that impulsivity seems to be mediated by the orbitofrontal, nucleus accumbens, and amygdala regions of the brain (Hollander & Evers, 2001). Although serotonin dysregulation and hypofunction seem to have a central role in these disorders, to differing degrees impulsivity is probably affected by highly interconnected serotoninergic, noradrenergic, dopaminergic, opioid, and γ-aminobutyric-acid systems (GABA) (Hollander & Evers, 2001).

In addition to these theories about the etiology of ADHD, researchers have also focused on the psychological mechanisms of ADHD in order to bolster their biological theories. Quay (1988) hypothesized that reduced brain activity in the behavioral inhibition system may encompass the decreased effectiveness of punishment to inhibit behavior or regulate behavior. An overactive behavioral activation system may account for the relative effectiveness of reward (versus recruitment) to stimulate or regulate behavior (Quay, 1988).

A functional-behavioral approach coined by Zentall (1985) theorized that thresholds of arousal in children with ADHD were higher than those of normal children. According to this theory, the function of wanting a sufficient level of central nervous system arousal leads children with ADHD to increase attention to high arousing stimuli (creates inattention). They utilize inattentive and activity level behaviors to overcome low environmental stimulation, thus children and adolescents with ADHD display sensation seeking behavior and are oversensitive to the changing environment around them while paying little attention to low-level stimulation tasks such as reading or listening to instruction.

At the behavioral level, children and adolescents with ADHD who are highly active, inattentive, and impulsive will be less likely than their peers to successfully cope with developmental progress toward self-regulation, time, and the future (Barkley, 1996). Self-regulation difficulties may stem from having an impaired sensitivity to behavioral consequences, an impaired command of behavior due to inconsistent schedules of reinforcement, and/or an impaired sense of rule-governed behavior. Barkley (1990) conceptualizes ADHD as the diminished capacity to inhibit and regulate behavior, and this diminished capacity stems from a biological source.

In addition to suppressed ability to inhibit and regulate behaviors, ADHD symptoms have been associated with some cognitive impairment. These cognitive impairments all fall within the domain of “executive functions” as conceptualized by neuropsychologists or “metacognition” as conceptualized by developmental psychology

(Barkley, 1996). Research has shown that executive functioning and metacognition are mediated by the frontal cortex, particularly by the prefrontal lobes (Fuster, 1989; Stuss & Benson, 1986), and the frontal cortex has been implicated in ADHD (Barkley, 1996). Brain imaging research studies have suggested that children with ADHD have decreased regional cerebral blood flow in parts of the prefrontal cortex, alterations in prefrontal cortical asymmetry, right frontal-striatal circuitry, and the cerebellum, and a dopaminergic midbrain dysfunction at the level of the dopaminergic nuclei (Linnet et al., 2003). The lateral temporal, prefrontal, and inferior parietal cortices are strongly interlinked with one another anatomically, suggesting that this attentional-action network is anatomically disturbed in children who have attention-deficit hyperactivity disorder (Sowell, Thompson, Welcome, Henkenius, Toga, & Peterson, 2003).

A maturity hypothesis surfaced in ADHD research because research demonstrated that some areas of the brain do not reach full maturity until late adolescence (Martin, Foels, Clanton, & Moon, 2004). The frontal cortex region of the brain matures more slowly than other regions, and it is implicated in the etiology of ADHD because it is involved in controlling impulses that might interfere with learning, maintaining attentional control, and engaging in planning ahead behavior (Pennington & Ozonoff, 1996). The children who have the most biologically immature frontal cortex region would be expected to have difficulty directing their behavior when a goal is remote or abstract, focusing or sustaining attention, and in inhibiting responses when appropriate (Bradshaw, 2001). Often the children with the most difficulty in inhibiting activity are males because the frontal cortex is slower to develop in males than females (Castellanos, 1999).

Season-of-Birth

One aspect of the ADHD research that has received little attention is whether or not children with ADHD are disproportionately born during some times of the year. This type of research is often referred to under the rubric of “season-of-birth.” Season-of-birth studies typically examine how annually occurring environmental factors adversely affect prenatal development particularly of the central nervous system. For example, maternal viral infections, occurring more frequently during the winter months can have detrimental impacts on the developing central nervous system. Thus, these viral infections could be linked to later psychopathology (Mick, Biederman, & Faraone, 1996). Measles and cytomegalovirus infections, capable of causing fetal damage, also have a seasonal incidence. Among the disorders that have been associated with season-of-birth are: schizophrenia, autism, dyslexia or Reading Disorder, glaucoma, allergic sensitization, asthma, allergic rhinitis, and menstrual disorders (Castrogiovanni, Iapichino, Pacchierotti, & Pieraccini, 1998).

Researchers have explored variables such as climate, diet, work activities, and incidence of holidays as potential influences on the development of seasonal birth patterns in individuals. The relationship between season-of-birth and the risk for psychopathology has been examined in dozens of countries, and researchers have now contributed over 250 published studies considering this association, particularly as it relates to schizophrenia (Castrogiovanni et al., 1998).

Season-of Birth and Schizophrenia

Tramer (1929) appears to have been the first researcher to report on possible season-of-birth effects in schizophrenia (Castrogiovanni et al., 1998). Tramer’s (1929) research found an excess of births from December to March among 2,100 cases of schizophrenia. Since Tramer's inaugural study, over 100 studies have been published on season-of-birth effects in schizophrenia, and in the northern hemisphere schizophrenics are born in disproportionately high numbers in late winter or early spring (Barr, Mednick, & Munk-Jorgensen, 1990; Castrogiovanni et al., 1998; Dalen, 1975; Takei, Murray, Sham, O'Callaghan, Glover, & Murray, 1995). The significant excess of schizophrenics born in the winter and early spring (December to May) correspond with a significant excess of schizophrenics born between June and October in the southern hemisphere (Castrogiovanni et al., 1998).

Some researchers have found gender differences in birth patterns of schizophrenia. For example, a significant trend towards an increase in winter births for male individuals with schizophrenia was found by Iwanami, Kamijima, Kosuga, Sasaki, Tanabe, and Tatsumi (2002). Female schizophrenic subjects did not manifest this trend. Sex differences in season-of-birth were not found in earlier research by Dalen (1968). Selten, Dijkgraaf, Graaf, and Kahn (1997) also found a lack of differences in the season-of-birth for men and women.

Congruent with other season-of-birth research, maternal viral infections have been implicated as being a risk factor in the multifactorial pathogenesis of schizophrenia (Altamura, Bassetti, Bocchio, Mundo, & Santini, 2003). Some researchers hypothesize that a viral infection (maternal viral infections), or some other perinatal difficulty associated with winter and early spring births, contributes to temporal lobe damage and consequent faulty physiological activity in patients with schizophrenia (Castrogiovanni et al., 1998).

The timing of the vulnerability period may relate to the role a viral infection may play in the etiology of schizophrenia (Barr et al., 1990). Neuronal migration, an explosive increase in brain growth, and an increase in the risk of hemorrhage due to the dissolution of the germinal matrix all occur at the end of the second trimester of fetal development (Barr et al., 1990). Although neuronal migration is under genetic control, a viral infection during a critical period of development may mimic the genetic influence (Barr et al., 1990). This is significant because disrupting the neuronal migration process from the periventricular area to a variety of predetermined sites on the cortex can produce many of the cytoarchitectonic deviations, disruptions in cell orientations, and the decreased cell densities noted in histopathological studies of the brains of schizophrenics (Barr et al., 1990). Another related hypothesis is the alteration of the immune system hypothesis. Altamura et al. (2003) hypothesized that immune response factors may play a role in disease pathogenesis, but probably in specific subgroups of patients.

Season-of-Birth and Autism

Beginning in the 1980's, researchers examined whether a connection exists between autistic disorder and season-of-birth (Castrogiovanni et al., 1998). A significantly higher rate of births of autistic children was found in March and August when they were compared with the general populations' birth distribution (Castrogiovanni et al., 1998). Two studies (Bartlik, 1981; Konstantareas, Hauser, & Lennox, 1986) reported a pronounced birth excess in March and August for lower functioning, nonverbal autistic individuals. Stevens, Fein, and Waterhouse (2000) also found a significant elevation in March for a Boston sub-sample made up of low-functioning boys with autism. A fourth study by Gillberg compared 100 individuals with autism to "autistic like" and age-matched children (as cited in Barak, Ring, Sulkes, Gabbay, & Elizur, 1995). The autistic group had a higher rate of March births (Barak et al., 1995). All of the above studies were performed in countries with similar climates (Sweden and North America).

A study by Barak et al. was conducted in a country with a different climate, Israel (Barak et al., 1995). These researchers collected data for patients with autism who were registered with the National League for Autism in Israel (N = 188) during the years 1964-1986, and this data was compared with monthly distribution data of live births in Israel for the corresponding time period. The results of this study mirrored what had been previously found in season-of-birth and autism studies. They found a significant increase for patients with infantile autism in March and August and this association was true for each year throughout the study (Barak et al., 1995). Barak and colleagues concluded that since the study was conducted in a different climatic area, it added greater weight to the earlier findings that March and August births are a risk factor for the development of autistic disorder (Barak et al., 1995).

The consistent findings of a significant increase of autistic children born in March and August raises questions about what is occurring during the time of gestation that might contribute to this pattern (Castrogiovanni et al., 1998). One hypothesis that addresses the time of gestation question is fetuses who were conceived during the summer months experience winter during the second trimester of pregnancy. Winter is linked with nutritional and vitamin deficiencies and with viral infections, and these calamities may have an adverse affect on a group of highly vulnerable fetuses, either during the first months of life or around the time of birth or during intrauterine life (Castrogiovanni et al., 1998).

Season-of-Birth and Specific Learning Disabilities

Researchers have examined whether specific learning disabilities have any association with a season-of-birth. Reading disability, or dyslexia, has received the most attention from researchers that have investigated whether or not there is a season-of-birth connection with specific learning disabilities. Research by Livingston, Adam, and Bracha (1993) indicated that dyslexic birth more commonly occurred during May, June, and July, which suggests a true seasonality. Five-year birth cohorts were analyzed and early summer birth accounts for 24 to 71% of dyslexia cases (Livingston et al., 1993). These authors, similar to many other researchers, have suggested a maternal viral infection hypothesis. They suggested that second trimester of pregnancy is when the viruses can have the most negative outcomes on the fetus's brain and nervous system development.

In another study concerned with season-of-birth and specific learning disabilities, Martin, Foels, Clanton, and Moon (2004) attempted to determine for 28 Northeast Georgia counties if achievement levels, retention rates, and rates of specific learning disability diagnoses followed the same general seasonal birth pattern found in previous studies: that children born in the summer are more likely to have low achievement, school failure, and more referrals for psychological evaluations. The study revealed that children born June through August performed more poorly on standardized achievement tests, were more frequently diagnosed as having a specific learning disability, and were more frequently retained or redshirted at the time of school entry (Martin et al., 2004). .

Season-of-Birth and ADHD-Related Disorders

Attention-Deficit/Hyperactivity Disorder (ADHD) and its connection with season-of-birth have been examined by Mick et al. (1996). One hundred forty boys with DSM-III-R diagnosed ADHD and 120 normal controls were examined to determine if season-of-birth was associated with ADHD diagnoses (Mick et al., 1996). The comparison between children with ADHD and normal controls did not yield a statistically significant effect for season of birth (Mick et al., 1996). However, significant effects were revealed for children with ADHD that also had a learning disability and children with ADHD that did not have psychiatric comorbidity (Mick et al., 1996). Mick et al. (1996) concluded that there may be a seasonal pattern of birth for subtypes of ADHD.

The construct of impulsivity has been explored by researchers that have examined human impulsive behaviors to determine if they have a seasonal birth pattern. One specific form of impulsive behavior, suicide, has been linked to a seasonal birth pattern in several studies. Chotai (1999) investigated connections between season-of-birth and cerebrospinal fluid levels of monoamine metabolites, and methods of suicide (Chotai, 1999). Previous research has indicated that low levels of the serotonin metabolite 5-hydroxyindoleacetic acid (5-HIAA) and the dopamine metabolite homovanillic acid (HVA) in the cerebrospinal fluid have been associated with impulsivity, suicidal behavior, and aggression (Chotai, 1999). Chotai (1999) discovered that for the Stockholm, Sweden sample, individuals born between February and April had significantly lower CSF levels of 5-HIAA. During the late fall and winter months, October to January, the Stockholm Sweden sample revealed significantly higher cerebrospinal fluid levels of HVA, HVA/5-HIAA, and HVA/MHPG (norepinephrine metabolite) (Chotai, 1999).

Season-of-Birth and Asthma

In a study by Aberg (1989) the prevalence of asthma and allergic rhinitis was analyzed in relation to birth month in two cohorts of 18-year-old Swedish males born in 1953 (n = 55, 393) and 1963 (n = 57, 150), in schoolchildren (n = 19, 814) and in children with defined specific allergies (n = 1080). The study discovered among the 18-year-olds, a marked variation with respect to birth season was only found in males born in 1963, with the highest prevalence of asthma in those born August-January and of allergic rhinitis in those born November-May (Aberg, 1989). Thus, the seasonal birth pattern of children with asthma (August-January) differed from the overall seasonal birth pattern for children in the Other Health Impaired special educational category (April-August).

Season-of-Birth and Diabetes

Samuelsson, Johansson, and Ludvigsson (1999) examined a cohort of 1248 children (702 boys, 546 girls) from seven pediatric departments in the south east part of Sweden for potential season-of-birth links with insulin dependent diabetes. The study found a small but significant difference in the monthly pattern of births in children with diabetes compared with the general population (df = 1, x^2 = 20.87, p < 0.04), mostly because fewer diabetic children than expected were born in October (x^2 = 12.24, p < 0.01, O/E = 0.66) (Samuelsson, Johansson, & Ludvigsson, 1999). The study also concluded that more children with insulin dependent diabetes were born during the months of July and August when compared to the general population of births in Sweden

(Samuelsson, Johansson, & Ludvigsson, 1999). The birth pattern for children with diabetes (spike in July and August and a nadir in October) does not fit the overall seasonal birth pattern for children in the Other Health Impaired special education category (April-August).

Season-of-Birth and Epilepsy

Recent research by Procopio, Marriot and Williams (1997) indicates a pre-perinatal disruption of the neurodevelopment as being the cause of at least some of these epilepsies of unknown etiology. The seasonal birth patterns of a large sample of epileptic patients discharged from NHS hospitals in England and Wales was examined (Procopio, et al., 1997). The results illustrated that the seasonality of the births in the epileptic sample was significantly different from that of the general population, with an excess of patients born in December and January and a deficit of those born in September (Procopio et al., 1997). This "seasonality' was present only in the patients born before the late 1950s (Procopio et al., 1997). These results are suggestive of the existence of an etiological factor for epilepsy with a seasonal presence in the environment and which is epileptogenic when acting in the pre-perinatal period (Procopio et al., 1997). Prenatal infections, obstetric complications and nutritional deficiencies are amongst the hypotheses developed on the nature of this agent(s) (Procopio et al., 1997).

Season-of-Birth in Valvular Heart Disease

Researchers have demonstrated seasonal variations of birth dates in children with congenital valvular heart disease and in adults dying from valvular heart disease (D. Bosshardt, Ajdacic-Gross, Lang, M. Bosshardt, Bopp, Addor, & Gutzwiller, 2005). The findings are based on the 1989-98 Swiss EUROCAT data, and on 1969-94 Swiss mortality records (D. Bosshardt et al., 2005). Both data sets showed excesses between December and March, consistent in different forms of valvular disease and in both sexes (D. Bosshardt et al., 2005). The seasonal birth pattern of valvular heart disease (December – March) did not match the general seasonal birth pattern of children in the Other Health Impaired special education category (April – August).

Factors Associated with Season-of-Birth: Toward a Mechanism of Effect

Seasonal environmental variations such as temperature and photoperiod have been linked to seasonal birth rate patterns in the general population. In addition, biological variations such as prematurity have also been connected to seasonal birth rate patterns in the general population. Regional differences in the birth rate pattern of the general population have been discovered, and they have connected to geographical latitudinal differences in temperature. European-Americans and Nonwhites in the general population who live in the southern United States have their lowest number of births during the April to May period and their highest birth rate in August and September (Greer, 2004). The nadir of births in the general population during the April to May period can also be seen among nonwhites in northern states, although the pattern is more pronounced in southern states (Lam & Miron, 1994).

A markedly different seasonal birth pattern for the general population is evident in Western Europe, where the highest, not the lowest, numbers of births occur in the spring. The most persistent and well-defined seasonal birth rate patterns have been found in zones of extreme summer heat. If regular annual events such as transitions in temperature affect seasonal birth patterns, it may be anticipated that the seasonal birth patterns observed in the northern hemisphere would be reversed below the equator: in other words, displaced by six months (Greer, 2004). South Africa demonstrated the expected displacement because the greatest number of births for both European-Africans and Black-Africans occurred in September, a difference of about a half-year from the birth peak in Europe (Lam & Miron, 1994).

The regularity of day length or photoperiod changes have been implicated in some season-of-birth research. Researchers have hypothesized that biochemical responses to length of daylight exposure may be a contributory factor in some season of birth patterns for some individuals (Gortmaker, Kagan, Caspi, & Silva, 1997).

Research regarding nutrition and daylength (photoperiod) was conducted by Martin and Kimlin (2002) in their study of vitamin D as a possible influence on season-of-birth patterns of neurodevelopment. When skin is exposed to the ultraviolet (UV) radiation in sunlight, vitamin D is produced. Vitamin D is hypothesized to contribute to development and function of the nervous system. Martin and Kimlin (2002) hypothesized that subnormal level of maternal vitamin D may be implicated in increased risk for mental retardation. A significant relationship was discovered between amount of available UV radiation during the first and second months of gestation and births of children with mental retardation.

Another season-of-birth avenue that has been hypothesized to affect neurodevelopment is maternal viral infections. Prenatal exposure to influenza and the polioviruses have been implicated in increasing schizophrenic births in several studies. Studies have indicated that increased schizophrenic births start approximately three months after the onset of influenza epidemics (see review by Greer, 2004). Researchers have suggested that the critical development period of the second trimester may have sustained some teratogenic insult. The mechanisms of maternal viral infections are still unclear, although immune system response, flu symptoms (fever and nausea) and influenza treatment all have been mentioned as possibilities (Dombrowski, Martin, & Huttunen, 2003; Lynberg, Khoury, Lu, & Cocain, 1994).

Seeger, Schloss, Schmidt, Ruter-Jungfleisch, and Henn (2004) later examined the role of the DRD4*7R allele in a refined subgroup of children with Hyperkinetic Disorder (HD) and Conduct Disorder (CD) (ICD 10; F90.1) with respect to the season-of-birth. 163 healthy controls and 64 patients diagnosed for HD + CD were genotyped for the DRD4* 7R allele and correlated with their season-of-birth (Seeger et al., 2004). Genotyping was conducted without any prior knowledge of diagnostic status (Seeger et al., 2004). These authors chose the length of the photoperiod as a more specific definition of the season-of-birth. The sample's ethnicity was 100 percent Caucasian.

There were no significant differences in seasonal birth patterning between the genotyped 163 controls (43.6 % born in autumn/winter) and the 64 patients (50 % born in autumn/winter) (Seeger et al., 2004). Neither the presence of the DRD4*7R allele nor the season-of-birth represents a risk factor for HD + CD per se (Seeger et al., 2004). However, when analyzing mutual interactions of the season-of-birth and the DRD4 gene polymorphism the data demonstrated a significant correlation between these variables and HD + CD (Seeger et al., 2004). Children with HD + CD born in autumn and winter showed significantly fewer DRD4*7R alleles (12.5 % (4)), than those born in spring and summer (50 % (16)) (Seeger et al., 2004). Interestingly, the inverse relation was manifested in the healthy controls (43.7 % (3)) versus 26.1 % (24)) (Seeger et al., 2004).

The importance of season-of-birth on birth weight has been discovered in numerous studies. Studies have demonstrated that, in general, babies have a higher mean birth weight during the winter period and a lower mean birth weight during the summer period (Van Hanswijck de Jonge, Waller, & Stettler, 2003). More premature infants are being saved from infant death than ever before. Children with these low birth weights and levels of prematurity have very high risks of psychopathologies (Hack & Fanaroff, 1999). The increase in living premature born children is important to season-of-birth research on ADHD because these premature children are more susceptible to eventually having ADHD or some other psychological disorder.

Not only do children born premature or with low-birth weight run a greater risk of having a physical debilitating condition, they also have a greater chance of having subtle developmental delays in social, behavioral, and cognitive domains (Barlow & Lewandowski, 2000). Often these subtle developmental delays in social, behavioral, and/or cognitive domains go undetected until a child reaches school age (Barlow & Lewandowski, 2000). Pre-term children were held back from moving to the next grade and were diagnosed with learning disabilities by their schools more frequently than full-term children, thus pre-term children required more educational support (Barlow & Lewandowski, 2000).

Research has shown that 33% of premature babies with very-low birth weight grow up to have behavioral and psychiatric problems (Harrison, 2003). The most common behavioral or psychiatric problem that very-low birth weight premature babies face is hyperactivity or full-fledged ADHD (Harrison, 2003). Low birth weight premature babies also grow up to have a higher rate of psychiatric disorder. One study examining low birth weight (below 2000 g) premature babies at age six found that ADHD (16%) was the most common psychiatric disorder in this group of children, while (22%) of this sample had at least one psychiatric disorder (Harrison, 2003).

Summary

Attention-Deficit/Hyperactivity Disorder is a neurodevelopmental disorder that affects between 3 and 7 percent of the school age population. Some of these children with ADHD will continue to struggle with the symptoms of the disorder (hyperactivity, impulsivity, and inattention) into adulthood. Children with ADHD are classified into the Other Health Impaired Special Education category by the U.S. Department of Education. Children with ADHD comprise more than 80 percent of children in the OHI Special Education category. Researchers do not know the etiology of ADHD. Currently, biological and neurological theories are receiving more emphasis with researchers in the ADHD field than environmental theories since ADHD tends to occur across generations in families.

A budding field in the psychological research literature is season-of-birth research. Season-of-birth research examines the effects of annually occurring environmental variables on birth patterns in the general population and in populations with psychopathology. Thus far, schizophrenia has been the most widely researched disorder in the season-of-birth research literature; although some season-of-birth research literature exists involving learning disabilities, autism, and ADHD. Environmental variables such as photoperiod and maternal viral infections have been linked to seasonal birth patterns with some of these psychological disorders. This study aims to discover if a seasonal birth patterns exists for children in the Other Health Impaired Special Education category.

CHAPTER 3

METHOD

Sample

A sample of 9, 970 children (between the ages of 4 and 21 years) who had an Other Health Impaired (OHI) special education placement in 44 of the most northern counties in Georgia was studied. The northern Georgia counties provided birth dates and demographic data for each child receiving special education services in the public schools of the county. Data were collected in the spring of 2002, and included children born from 1980 through 1999.

Other health impairment is a classification category used by educators in the State of Georgia to categorize those children and adolescents who are having limited strength, vitality, or alertness including a heightened alertness to environmental stimuli, which results in limited alertness with respect to the educational environment. This limited alertness with respect to the educational environment is due to chronic or acute health problems such as asthma, attention-deficit/hyperactivity disorder, diabetes, epilepsy, heart condition, hemophilia, lead poisoning, leukemia, nephritis, rheumatic fever, and sickle cell anemia. In addition, the limited alertness in the educational environment adversely affects a student's educational performance. Several school districts estimated that up to 90 % of their students in OHI have diagnoses of ADHD.

The OHI sample consisted of 7, 153 males (71.8 %) and 2, 817 females (28.3 %). This sample is ethnically diverse; 7,021 students were European American (non-

Hispanic) (71.1 %) and 2,257 were African-American (22.9 %). Other racial groups are sparsely represented. These groups include 302 (3.1 %) Hispanic students, 27 (0.3%) Native Americans, 83 (0.8%) Asian-Americans, and 184 students (1.9 %) did not provide race information.

This study focused on students born in the period from September, 1984- August, 1995. Sample sizes were too small to justify inclusion of data into the final sample for the following years: 1980-1983 and 1996-1998. Students born during 1980-1983 were between 17 and 21 years of age when the data was collected during 2001. It is hypothesized that many of these students either dropped out of school or were no longer receiving special education services, thus they were missing from the sample. Students born during 1996-1998 were between 3 and 6 years of age during 2001. These students were represented in lower numbers because they may have been too young to receive an OHI diagnosis or too young to receive special education services through the OHI special education category. Thus, an adjusted sample size of 8, 602 students, representing students in the OHI special education category from September,1984-August, 1995 was utilized in all statistical analyses.

This reduced OHI sample consisted of 6, 154 males (71.5 %) and 2, 448 females (28.5 %). This sample consisted of 6,475 European American (non-Hispanic) students (75.3 %) and 2,127 African-American students (24.7 %).

To assess the potential impact of season-of-birth upon students in the OHI special education category, it is imperative to have a sizable number of students who were born during each month. Table 1 presents the distributions of births of all children, across month of birth for the period September, 1984 through August, 1995. Examination of

Table 1 indicates that data from more than 610 students are available for each month of birth. This distribution affords a large number of children in the OHI special education category per month to test the hypotheses of interest in the proposed study.

Table 2 presents total numbers of students and total percentages of students in the OHI special education category in Atlanta area counties that provided school district census data. Table 3 provides total numbers of students and total percentages of students in the OHI special education category in Northeastern Georgia counties that contributed school district census data and Table 4 presents total numbers of students and total percentages of students in the OHI special education category in Northwest area counties that provided school district census data. These data include all birth years and all ethnicities, and are presented in order to show the distribution of OHI students in the 44 counties studied.

Data Analytic Procedures

Chi-square analyses were conducted to determine if a seasonal birth pattern exists in children and adolescents who received services in the OHI special education category. Observed frequencies of births in the OHI special education population were compared to expected frequencies of births based on birth rates per month in the general population. The birth months were ordered from one to twelve beginning with January as number 1 and ending with December as number 12. Further, to adjust for differing numbers of days per month data were adjusted to the assumption that each month during the year has 30 days.

Table 1

Monthly Birth Pattern of All Students Classified in the Other Health Impaired Category from September 1984- August 1995

Month	**Total**
January	661
February	623
March	685
April	766
May	795
June	826
July	911
August	864
September	612
October	619
November	595
December	645

Table 2

Total Numbers of Students and Total Percentages of Students in the Other Health Impaired Special Education Category in Atlanta area counties that provided School District Census Data

County	Total # of OHI students	Percent of OHI Total
Fulton	716	7.18
Cobb	2202	22.09
Dekalb	911	9.14
Gwinnett	2390	23.97

Table 3

Total Numbers of Students and Total Percentages of Students in the Other Health Impaired Special Education Category in Northeast area counties that provided School District Census Data

County	Total # of OHI Students	Percent of OHI Total
Fannin	11	0.11
Towns	2	0.02
Rabun	12	0.12
Lumpkin	19	0.19
White	34	0.34
Habersham	33	0.33
Stephens	43	0.43
Hall	131	1.31
Franklin	93	0.93
Hart	58	0.58
Jackson	62	0.62
Madison	90	0.90
Elbert	22	0.22
Barrow	108	1.08
Clarke	28	0.28
Oconee	47	0.47
Wilkes	1	0.01
Lincoln	14	0.14

Walton	133	1.33
Morgan	46	0.46
Greene	5	0.05
Taliaferro	3	0.03
Jasper	29	0.29
Putnam	55	0.55
Mcduffie	18	0.18
Glascock	7	0.07
Newton	216	2.17

Table 4

Total Numbers of Students and Total Percentages of Students in the Other Health Impaired Special Education Category in Northwest area counties that provided School District Census Data

County	Total # of OHI Students	Percent of OHI Total
Dade	641	6.41
Murray	113	1.13
Floyd	177	1.78
Bartow	235	2.36
Polk	211	2.12
Douglas	198	1.99
Heard	11	0.11
Coweta	337	3.38
Fayette	193	1.94
Henry	390	3.91
Butts	39	0.39
Rockdale	242	2.43
Walker	147	1.47

To make this adjustment, the observed frequencies of births were multiplied by (30/X) where X was the number of days in the month. For example, 30/ (31 – the number of days in July) equal (0.968). The result (0.968 in the example above) was multiplied by the frequency of observed OHI births during that month to create an OHI adjusted frequency group. A percentage of observed OHI births were calculated for each month. Additionally, a general population birth month percentage was calculated as the percentage of general population births in the state of Georgia.

A frequency estimate of the number of children in OHI that would be expected to be born each month was calculated from the births in the state of Georgia. The difference between the expected general population births in the state and the observed OHI adjusted birth month frequency was calculated. The Chi-Square goodness-of-fit test was applied to this 2 (observed vs. expected) by 12 (months) matrix.

In order to determine the stability of the birth rate for European-American and African-American children who received services in the Other Health Impaired (OHI) special education category during the years of this study, birth rate data for September, 1984 – August, 1995 was examined. Spectral analyses, a form of time series analysis, was utilized to determine if an annual cyclical birth rate pattern was evident in the data that was examined from September, 1984- August, 1995. Spectral analyses describe a time series in terms of the cycles of different frequency or period (length) that generate the series.

CHAPTER 4

RESULTS

Preliminary Analyses

The first question this research was designed to examine was the extent to which the sample of schools that provided data were representative of the North portion of the State of Georgia. This question was addressed initially by determining the similarity of ethnic composition between counties that provided special education census data and counties that did not provide these data. The counties that contributed census data and counties that did not contribute census data for this study were very similar in the percentage of each ethnic group represented (European-Americans –Yes counties – 61 %; No counties – 63 %, African-American – Yes counties – 29 %; No counties – 31 %, and Hispanics – Yes counties – 5 %; No counties – 3 %).

As a further check on the representativeness of the sample, the geographic distribution of districts providing data versus those that did not provide data was checked. Three regions were designated: Atlanta Metropolitan Area; Northeastern Georgia (not Atlanta); and Northwestern Georgia (not Atlanta). The distribution of schools in these areas is presented in Table 5. Table 5 reveals that the percentage of counties not providing data ranged from 24 % to 41 % across regions with a mean of 32 %. Thus, it was concluded that all three regions were roughly proportionally represented. This also helps insure a rural-urban representativeness since the Atlanta metropolitan area had about the same response rate as the more rural areas of Northwest and Northeast Georgia.

Table 5

Total Numbers and Percentages of Yes and No Counties in the Atlanta Metropolitan, East of Atlanta, and West of Atlanta Regions: 2001-2002

Region	Number of Yes Counties	Number of No Counties	Percentage of Yes Counties	Percentage of No Counties
Atlanta	4	2	67.00	33.00
East of Atlanta	28	9	76.00	24.00
West of Atlanta	13	9	59.00	41.00

The representative nature of the data could be biased in other ways, however. For example, the ethnicity of children placed in special education classes under the designation of Other Health Impairment (OHI) might be different from the ethnic distribution of the schools. Thus, the total numbers of European-American, African-American, and Hispanic students were recorded for each county from the Georgia County Guide for the school year from August 1999 to May 2000, and total numbers of European-American and African-American students within the OHI special education category were determined from the special education census data provided by the school districts between September, 1984 and August, 1995. The total percentages of each ethnic group for these counties in the 1999-2000 data were compared with the percentage of these ethnicities in the sample of OHI special education students (8,602 students total, September, 1984 through August, 1995) involved in this study. European-Americans represented 65 percent of the total number of students in the 1999-2000 school year data, and they represented 75.3 percent of the children and adolescents in the OHI special education category sample with birth dates between September, 1984 and August, 1995. African-Americans comprised 31 percent of the total number of students in the 1999-2000 school year data, and they represented 24.7 percent of the children in the OHI special education category sample with birth dates between September, 1984 and August, 1995. Hispanics made up 5 percent of the total number of students in the 1999-2000 school year data, and they were not represented in the OHI special education category sample with birth dates between September, 1984 and August, 1995.

Therefore, it was concluded that the ethnic makeup of children in the OHI special education category was similar to that of the counties studied, though modestly over representing the population of European-Americans and modestly under representing the population of African-Americans. Further, based on ethnicity figures the schools providing data for this project were quite similar to the schools in the region (See Table 5). Finally, the counties that provided data were proportional to those that did not across three regions of Northern Georgia (See Table 6). Thus, for reasons of ethnic similarity and proportional geographic sampling the counties studied seem generally representative of the region.

Description of Sample

Descriptive statistics are provided in tables 7-12 for each county represented in this study. Only counties that provided data for the study are included in the tables. The total number of students in the OHI special education category in each county that provided special education census data is contained in the column marked "Total OHI." The percent of European-American, African-American, and Hispanic students of the total number of students in the OHI special education category for the entire sample was calculated for each county. This percentage is listed in the column marked "Percent of OHI Total." The composite percentage of the total number of European-American, African-American, and Hispanic students in each school district was calculated. This percentage is contained in the column labeled "Percent of District Total."

Spectral Analysis

Figures 1 through 4 present the number of births per month of students in OHI. Spectral analyses, a form of time-series analysis, was utilized to confirm or disconfirm statistically that an annual cyclical spring-summer peak is occurring in the raw frequency

Table 6

Percentages of European-American, African-American, and Hispanic Students in Yes and No Counties in the Atlanta Metropolitan, East of Atlanta, and West of Atlanta regions: 2001-2002

Region	European-American Percentage Yes Counties	European-American Percentage No Counties	African-American Percentage Yes Counties	African-American Percentage No Counties	Hispanic Percentage Yes Counties	Hispanic Percentage Yes Counties
Atlanta Metro.	82.00	18.00	99.00	1.00	94.00	6.00
Northeast Georgia	80.00	20.00	52.00	48.00	85.00	15.00
Northwest Georgia	62.00	38.00	37.00	63.00	41.00	59.00

Table 7

Total Numbers of Students, and Total Numbers and Percentages of European-American, African-American, and Hispanic Students in Atlanta area counties that provided School District Census Data: 2001-2002

County	Total # of Students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	Hispanic Frequency	Hispanic Percentage	Percent of District Total
Fulton	65602	31620	48.20	25782	39.30	3543	5.40	92.90
Cobb	93169	62330	66.90	20497	22.00	5217	5.60	94.50
Dekalb	92951	10968	11.80	71386	76.80	4926	5.30	93.90
Gwinnett	104203	69399	66.60	15526	14.90	8649	8.30	89.80

- In cases where District Total Percent is less than 100, children from other ethnic groups were in the population (e.g. Asian).

Table 8

Total Numbers of Students, and Total Numbers and Percentages of European-American and African-American Students in the Other Health Impaired Special Education Category in Atlanta area counties that provided School District Census Data: 2001-2002

County	Total # of OHI students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	Percent of OHI Total
Fulton	716	479	66.90	203	28.30	95.20
Cobb	2202	1729	78.50	394	17.90	96.40
Dekalb	911	229	25.10	648	71.10	96.20
Gwinnett	2390	1793	75.00	413	17.30	92.30

* In cases where OHI Total Percent is less than 100, children from other ethnic groups were in OHI (e.g. Asian).

Table 9

Total Numbers of Students, and Numbers and Percentages of European-American, African-American, and Hispanic Students in Northeast area counties that provided School District Census Data: 2001-2002

County	Total # of Students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	Hispanic Frequency	Hispanic Percentage	Percent of District Total
Fannin	3062	3019	98.60	3	0.10	18	0.60	99.30
Towns	956	956	100.00	0	0.00	0	0.00	100.00
Rabun	2061	1939	94.10	12	0.60	76	3.70	98.40
Lumpkin	3250	3036	93.40	59	1.80	104	3.20	98.40
White	3064	2908	94.90	74	2.40	25	0.80	98.10
Habersham	5516	4711	85.40	121	2.20	469	8.50	96.10
Stephens	4291	3489	81.30	704	16.40	21	0.50	98.20
Hall	19475	14684	75.40	1169	6.00	3174	16.30	97.70
Franklin	3528	3031	85.90	452	12.80	25	0.70	99.40
Hart	3431	2402	70.00	995	29.00	14	0.40	99.40
Jackson	4966	4509	90.80	243	4.90	114	2.30	98.00
Madison	4478	3891	86.90	457	10.20	67	1.50	98.60
Elbert	3679	2115	57.50	1494	40.60	40	1.10	99.20
Barrow	8042	6450	80.20	981	12.20	177	2.20	94.60
Clarke	10769	3317	30.80	6192	57.50	765	7.10	95.40
Oconee	5239	4558	87.00	398	7.60	152	2.90	97.50
Wilkes	1886	820	43.50	1030	54.60	13	0.70	98.80
Lincoln	1470	810	55.10	651	44.30	1	0.10	99.50
Walton	9042	6980	77.20	1745	19.30	99	1.10	97.60
Morgan	2914	1818	62.40	1032	35.40	35	1.20	99.00
Greene	2264	509	22.50	1712	75.60	29	1.28	99.40
Taliaferro	137	13	9.50	117	85.40	3	2.20	97.10
Jasper	1905	1090	57.20	756	39.70	25	1.31	98.20
Putnam	2500	1115	44.60	1288	51.50	55	2.20	98.30
Mcduffie	4399	2169	49.30	2160	49.10	31	0.70	99.10

Columbia	18361	14872	81.00	2332	12.70	312	1.70	95.40
Glascock	545	488	89.50	55	10.10	0	0.00	99.60
Newton	10523	6966	66.20	3157	30.00	189	1.80	98.00

* In cases where District Total Percent is less than 100, children from other ethnic groups were in the population (e.g. Asian).

Table 10

Total Numbers of Students in OHI, and Numbers and Percentages of European-American and African-American Students in OHI in Northeast area counties that provided School District Census Data: 2001-2002

County	Total # of OHI Students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	Percent of OHI Total
Fannin	11	11	100.00	0	0.00	100.00
Towns	2	2	100.00	0	0.00	100.00
Rabun	11	11	100.00	0	0.00	100.00
Lumpkin	19	19	100.00	0	0.00	100.00
White	34	33	97.10	1	2.90	100.00
Habersham	32	32	100.00	0	0.00	100.00
Stephens	43	38	88.40	5	11.60	100.00
Hall	130	113	86.90	6	4.60	91.50
Franklin	92	83	90.22	9	9.78	100.00
Hart	58	42	72.40	16	27.60	100.00
Madison	90	87	96.70	3	3.30	100.00
Elbert	22	11	50.00	10	45.40	95.40
Barrow	108	91	84.30	14	13.00	97.30
Oconee	47	40	88.90	5	11.10	100.00
Wilkes	1	1	100.00	0	0.00	100.00
Lincoln	14	5	35.70	9	64.30	100.00
Walton	133	114	85.70	19	14.30	100.00
Morgan	46	33	71.70	13	28.30	100.00
Greene	5	2	40.00	3	60.00	100.00
Taliaferro	3	0	0.00	3	100.00	100.00
Jasper	29	20	69.00	5	17.20	86.20
Putnam	55	36	65.50	19	34.50	100.00
Mcduffie	18	13	72.20	5	27.80	100.00

Columbia	134	110	82.10	21	15.70	97.80
Glascock	7	6	85.70	1	14.30	100.00
Newton	212	142	67.00	67	31.60	98.60

* In cases where OHI Total Percent is less than 100, children from other ethnic groups were in OHI (e.g. Asian).

Table 11

Total Numbers of Students, and Numbers and Percentages of European-American, African-American, and Hispanic Students in Northwest area counties that provided School District Census Data: 2001-2002

County	Total # of Students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	Hispanic Frequency	Hispanic Percentage	% of District Total
Dade	2518	2495	99.10	8	0.32	5	0.20	99.60
Murray	6499	6168	94.90	19	0.30	247	3.80	99.00
Floyd	9883	9033	91.40	445	4.50	237	2.40	98.30
Bartow	11543	10285	89.10	900	7.80	231	2.00	98.90
Polk	6735	5018	74.50	1233	18.30	438	6.50	99.30
Douglas	16703	12293	73.60	3541	21.20	351	2.10	96.90
Heard	1971	1673	84.90	252	12.80	16	0.81	98.50
Coweta	15777	11501	72.90	3897	24.70	189	1.20	98.80
Fayette	19012	15343	80.70	2510	13.20	361	1.90	95.80
Henry	21748	17072	78.50	3784	17.40	370	1.70	97.60
Butts	3202	1956	61.10	1182	36.90	22	0.70	98.70
Rockdale	13412	9549	71.20	2937	21.90	510	3.80	96.90
Walker	8583	7922	92.30	472	5.50	51	0.60	98.40

* In cases where District Total Percent is less than 100, children from other ethnic groups were in the population (e.g. Asian).

Table 12

Total Numbers of Students in OHI, and Numbers and Percentages of European-American and African-American Students in OHI in Northwest area counties that provided School District Census Data: 2001-2002

County	Total # of OHI Students	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage	% of OHI Total
Murray	109	109	100.00	0	0.00	100.00
Floyd	174	157	90.20	13	7.50	97.70
Bartow	235	214	91.10	18	7.70	98.80
Polk	211	151	71.90	56	26.70	98.60
Douglas	198	137	71.40	53	27.60	99.00
Heard	11	11	100.00	0	0.00	100.00
Coweta	334	245	73.40	84	25.20	98.60
Fayette	190	160	84.20	24	12.60	96.80
Henry	390	291	75.80	85	22.10	97.90
Butts	39	31	81.60	5	13.20	94.80
Rockdale	242	168	69.40	69	28.50	97.90
Walker	147	142	97.90	3	2.10	100.00

* In cases where OHI Total Percent is less than 100, children from other ethnic groups were in OHI (e.g. Asian).

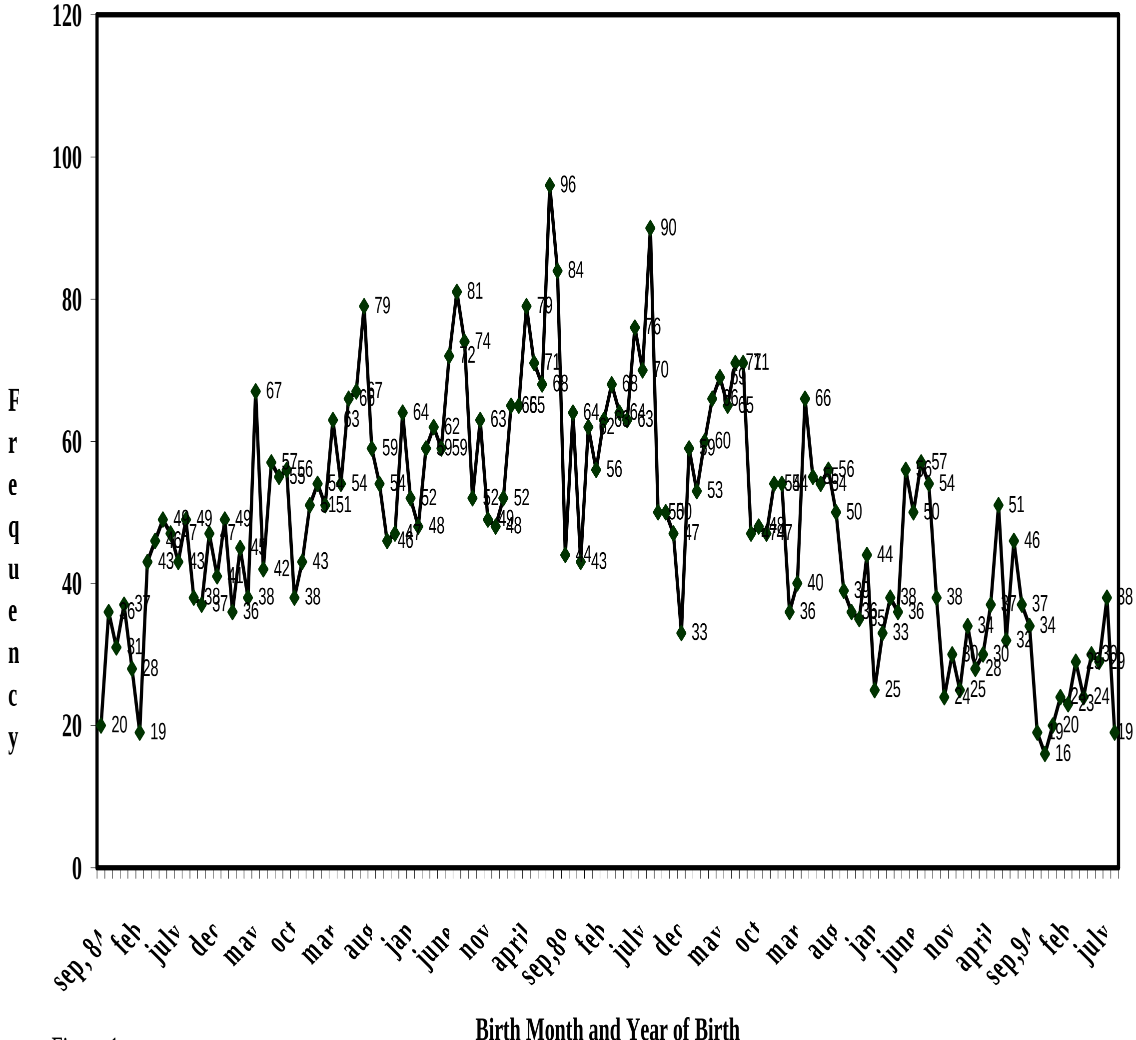

Figure 1

European-American Students with a Diagnosis of Other Health Impaired (OHI) by Birth Month and Year of Birth: Data Collected in 2002

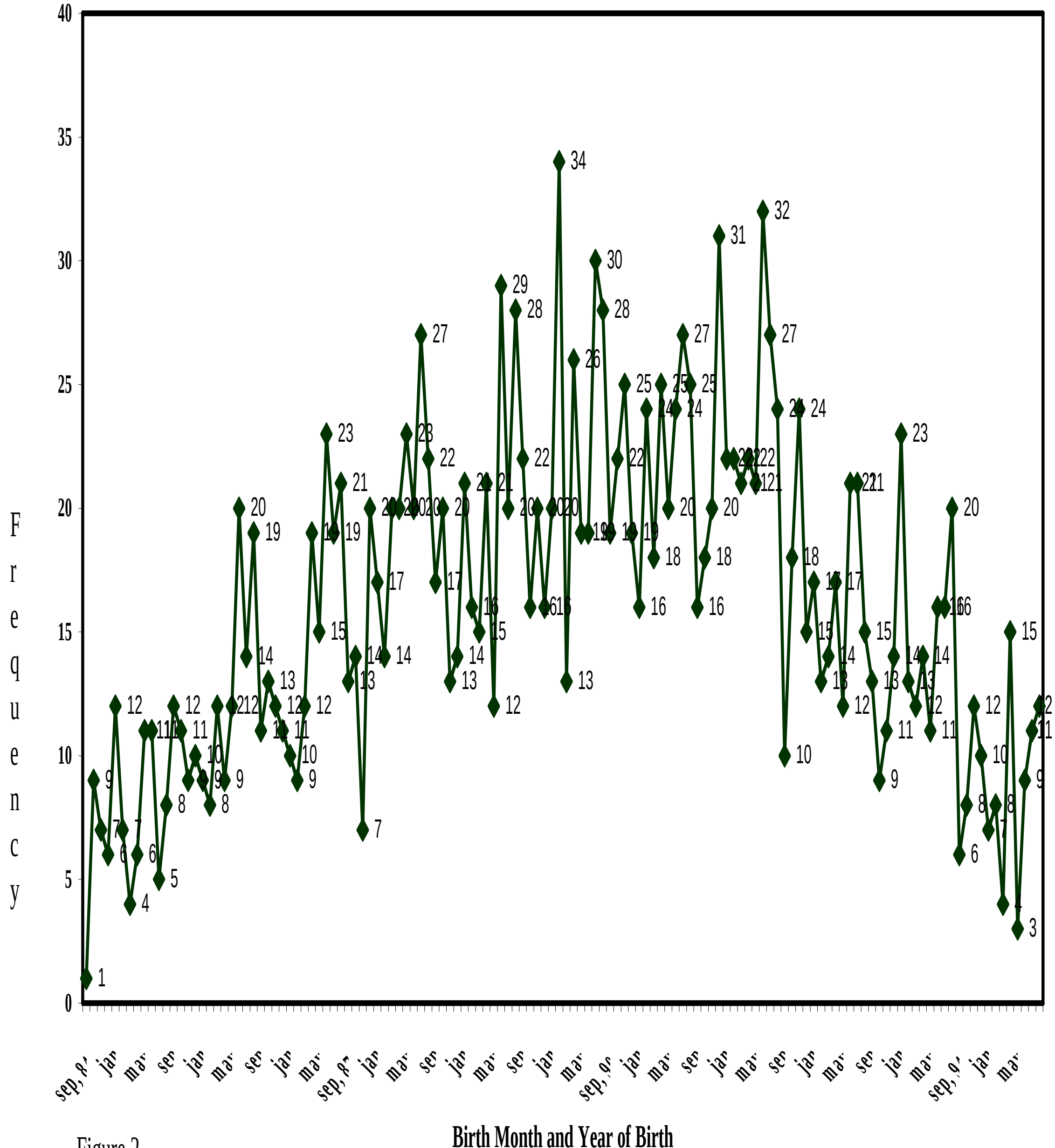

Figure 2

African-American Students with a Diagnosis of Other Health Impaired (OHI) by Birth Month and Year of Birth: Data Collected in 2002 data. Spectral analyses are designed to yield a description of a series in terms of the cycles of different frequency or period (length) that generate the series.

Figures 1 and 2 depict raw frequency data for European-American and African-American students diagnosed with OHI plotted across birth month for the period September, 1984 through August, 1995. Inspection of Figures 1 and 2 reveals two general trends. First, there is a general inverted ‘U’-shaped pattern to the data indicating that more European-American students with an OHI diagnosis were born during the birth years 1987 through 1990 than were born during other years. The peak period for African-American students was births during 1989-1991, somewhat later than for European-American students.

There are two possible reasons for this type of curve. The first possible reason involves age effects. Children are not likely to get diagnosed as needing OHI services before they enter the 2nd grade or after they enter the 10th grade. Normally, a child will receive a diagnosis warranting OHI special education services during the late elementary school years or during the early middle school years. The data for this study were collected in the 2001-2002 school year. Children who were born during 1984 would be the oldest students in the sample and they would be 17 or 18 years old (11th or 12th graders). The lack of OHI diagnoses rendered during the latter years of high school and the high school dropouts among the students in the OHI special education category may explain the lower frequency of students in the OHI special education category during the year 1995.

Further, students in the OHI special education category who were born during 1995 would be the youngest students in the sample and they would be 6 or 7 years old (1st or 2nd graders). In both cases, they would be expected to be in special education classes in lower numbers than those born around 1990.

The second trend in the frequency data that can be readily observed is some type of cyclical process that appears to be about 12 months in length. There appears to be a summer peak on an annual cycle. That is, more children born during the summer are diagnosed with OHI than during other periods.

However, this cyclical effect in the raw frequency data might be misleading because each month during the year does not have the same number of calendar days. To adjust for this discrepancy, data in this study were adjusted to the assumption that each month during the year has 30 days. To make this adjustment the assumed 30 days were divided by the number of days in the month in question. For example, 30/ (31 – the number of days in July) equal (0.967). The result (0.967 in the example above) will be multiplied by the frequency of observed OHI births during that month to create an OHI adjusted frequency group.

Adjustments were also made to the frequency data to get rid of a bell-curve trend (European-American grand mean = 588.64 and African-American grand mean = 193.36). This was done to facilitate the analysis of annual cycles and is a prerequisite for spectral analyses. That is, frequency of births for each year was adjusted to the grand mean with all variation within the year remaining as it had been prior to the adjustment. The adjustments centered annual variations around a grand mean in order to eliminate the bell-curve trend. Figures 3 and 4 display the frequency data adjusted for days per month and the general trend in the data.

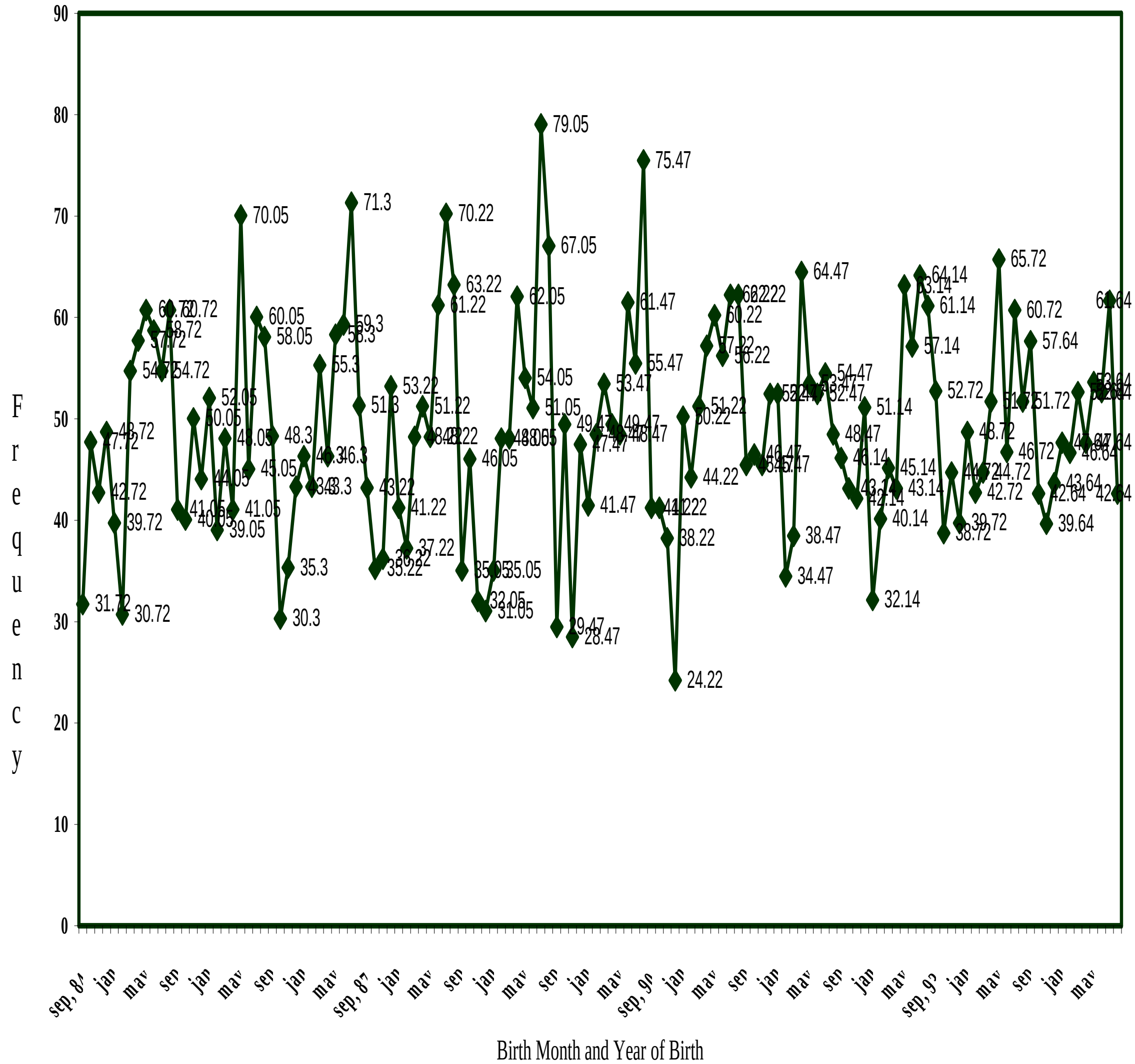

Figure 3

European-American Students with a Diagnosis of Other Health Impaired (OHI) by Birth Month and Year of Birth (Adjusted): Data Collected in 2002

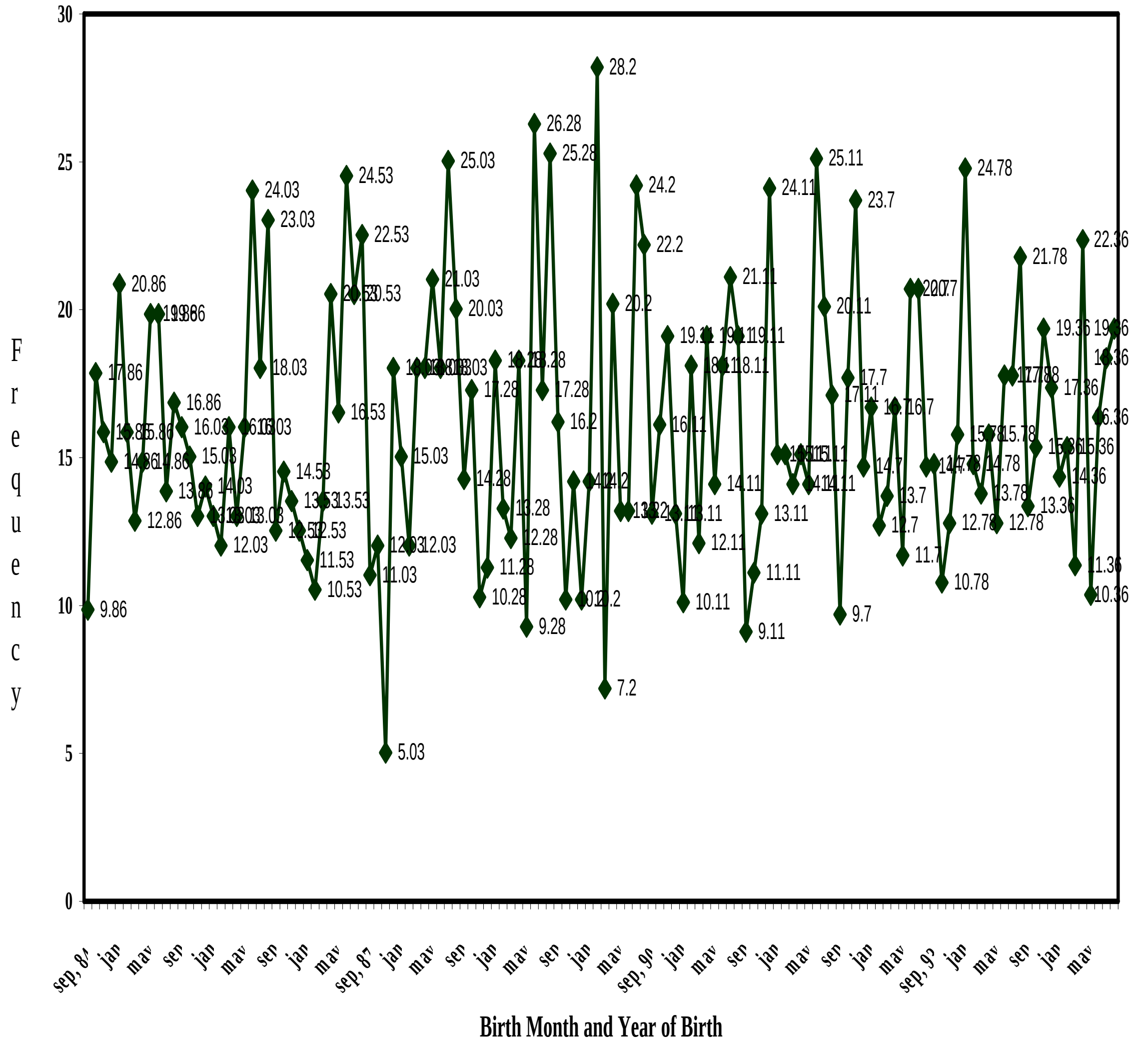

Figure 4

African-American Students with a Diagnosis of Other Health Impaired (OHI) by Birth Month and Year of Birth (Adjusted): Data Collected in 2002

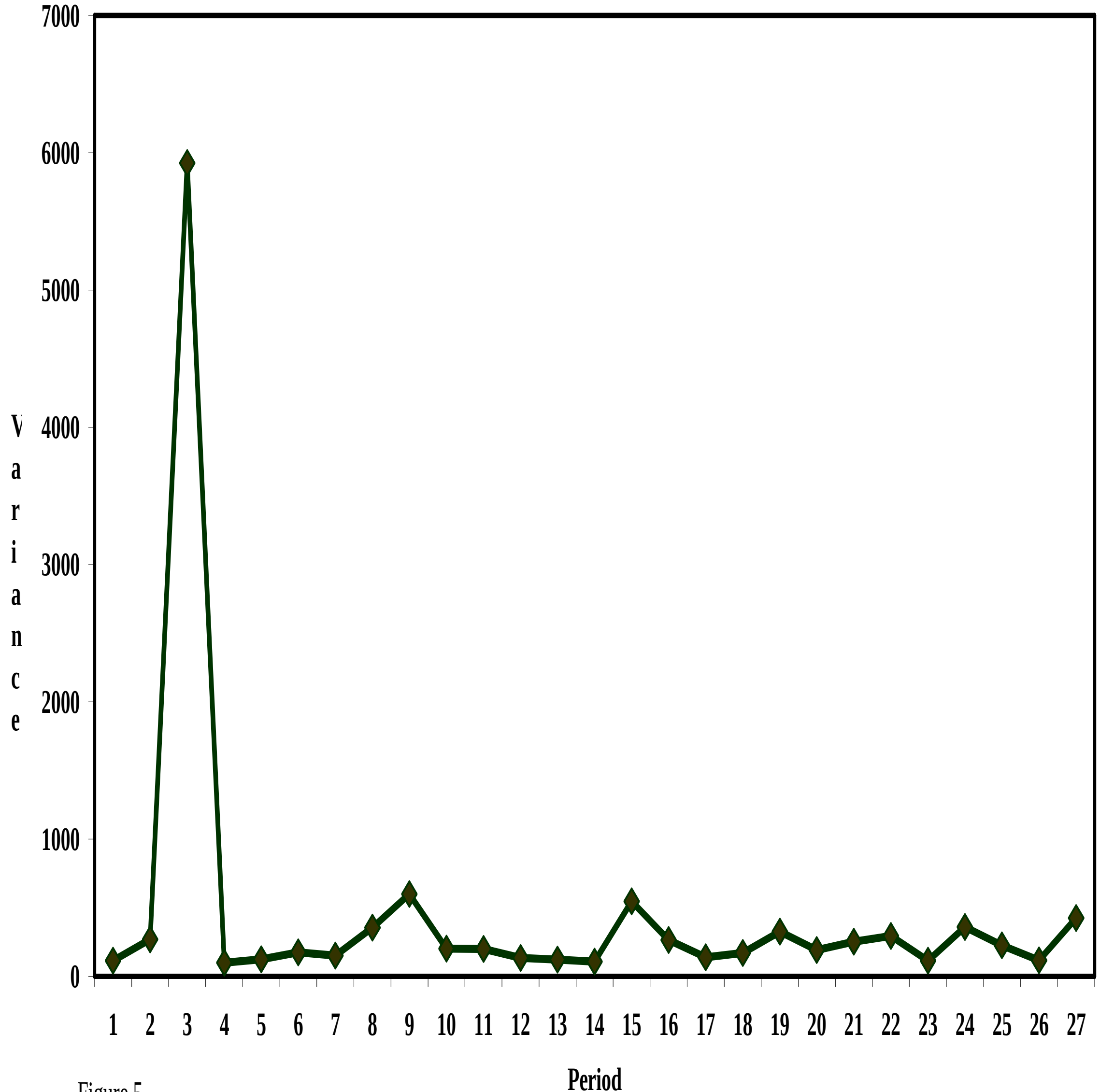

Figure 5

Periodogram for European-American Data

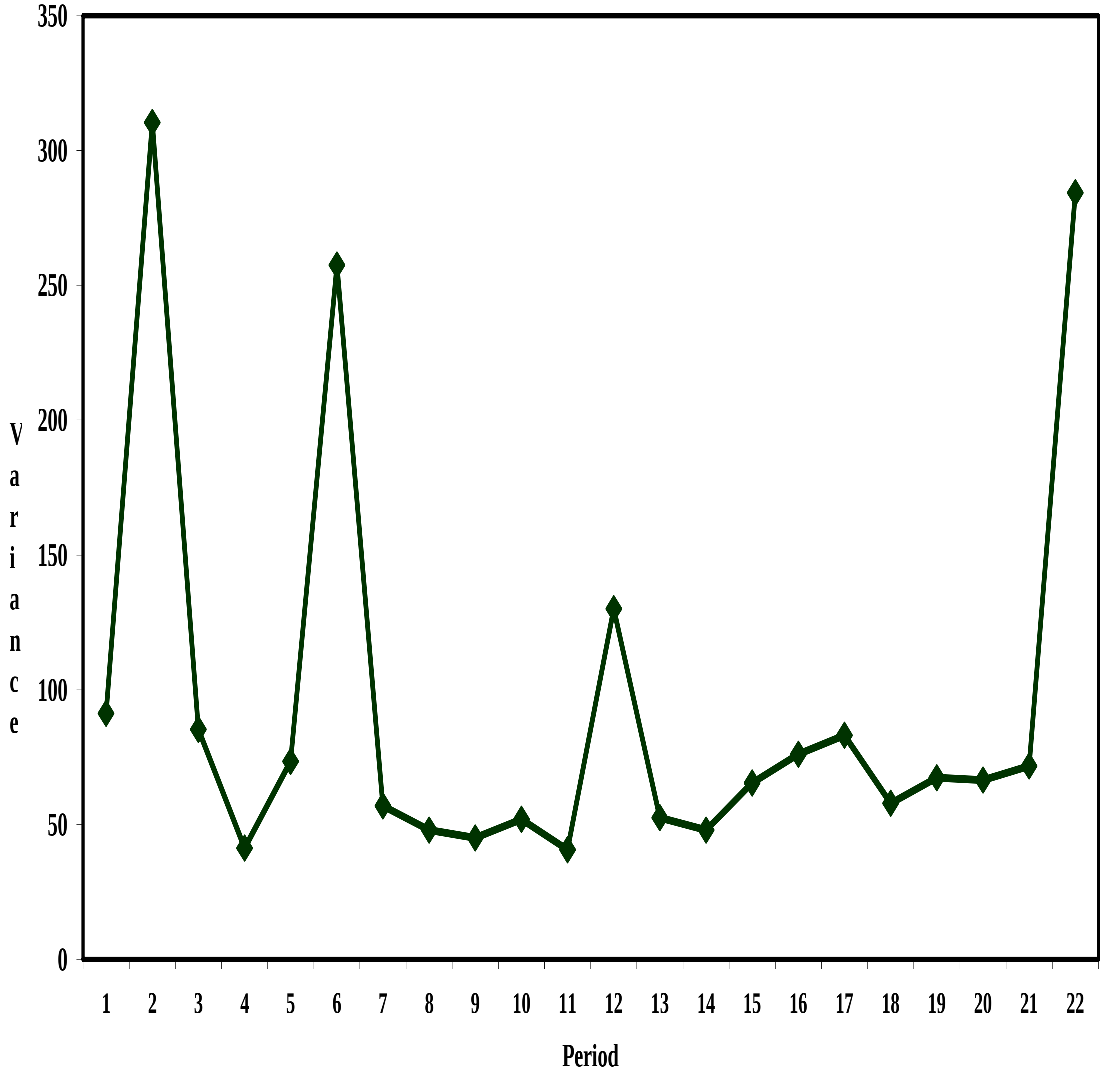

Figure 6

Periodogram for African-American Data

As a second step in the spectral analysis a graph called a periodogram (see Figures 5 and 6) is created, and it shows an estimate of the amount of variance of the series accounted for by cycles of each frequency. The raw frequency data in this sample was plotted on a scale of 0 to .5. Cycles tested included: 10/120 or (1/12 = .08) indicating a 12 month cycle, 20/120 or (2/12 = .16) indicating a six month cycle; 30/120 or (3/12 = .25) indicating a five month cycle; 40/120 or (4/12 = .33) indicating a four month cycle; 50/120 or (5/12 = .42) indicating a three month cycle; and 60/120 or (6/12 =.50) indicating a two month cycle. These values occurred along the X axis and natural log coefficients representing variance explained were placed on the Y axis. If the annual cycle was evident then a large peak should be manifested at 1/12 (or .08) in the periodogram graph.

<u>Results of Spectral Analysis</u>

Tables 13 and 14 represent the results of the spectral analyses that were conducted on the European-American data and the African-American data. The first column in each table includes the fraction of observations that were repeated during the cycle represented. The period (listed in Months) of the cycle is included in column two of tables 13 and 14. Column three contains the frequency of the fraction of observations during September, 1984 - August, 1995. The variance that is explained by the frequency of the fraction of observations during September, 1984 - August, 1995 is included in column 4. The fractions of observation with the greatest variance were statistically tested to determine their significance using the g statistic.

European-Americans had a significant annual cycle at the .05 alpha level (N = 135, critical value = .10452, r1 = .4297). R1 was calculated by dividing by the sum of

Table 13

Results of Spectral Analyses of European-American Data

Fraction of Observation	Period of Cycle (Months)	Frequency	Variance Explained Per Frequency
5/132	(26.4) 26 Months	.0379	114.18
10/132	(13.2) 13 Months	.0758	270.31
11/132	12 Months	.0833	5924.98
13/132	(10.2) 10 Months	.0985	100.37
16/132	(8.3) 8 Months	.1212	124.75
19/132	(6.95) 7 Months	.1439	174.38
20/132	(6.6) 7 Months	.1515	149.58
21/132	(6.3) 6 Months	.1591	355.44
22/132	6 Months	.1667	600.11
25/132	(5.3) 5 Months	.1894	200.38
28/132	(4.7) 5 Months	.2121	197.88
30/132	(4.4) 4 Months	.2273	133.05
31/132	(4.3) 4 Months	.2349	120.81
32/132	(4.1) 4 Months	.2424	107.22
33/132	4 Months	.2500	546.98
41/132	(3.2) 3 Months	.3106	265.32
42/132	(3.1) 3 Months	.3182	138.59
44/132	3 Months	.3333	169.56
48/132	(2.8) 3 Months	.3636	324.37
49/132	(2.7) 3 Months	.3712	192.66
51/132	(2.6) 3 Months	.3864	252.35
53/132	(2.5) 3 Months	.4015	294.12
54/132	(2.4) 2 Months	.4091	113.93

55/132	(2.4) 2 Months	.4167	359.53
63/132	(2.1) 2 Months	.4773	225.98
64/132	(2.1) 2 Months	.4849	117.37
65/132	(2.03) 2 Months	.4924	425.04

Note: Only those frequencies that had a Sum of Squares larger than 100 were included in the table.

Table 14

Results of Spectral Analyses of African-American Data

Fraction of Observation	Period of Cycle (Months)	Frequency	Variance Explained Per Frequency
10/132	(13.2) 13 Months	.0758	91.19
11/132	12 Months	.0833	310.41
12/132	11 Months	.0909	85.27
17/132	(7.8) 8 Months	.1288	41.24
20/132	(6.6) 7 Months	.1515	73.43
22/132	6 Months	.1667	257.52
23/132	(5.7) 6 Months	.1742	56.84
28/132	(4.7) 5 Months	.2121	47.86
30/132	(4.4) 4 Months	.2273	45.02
33/132	4 Months	.2424	51.89
38/132	(3.5) 4 Months	.2879	40.64
42/132	(3.1) 3 Months	.3182	130.00
44/132	3 Months	.3333	52.55
48/132	(2.8) 3 Months	.3636	47.88
49/132	(2.7) 3 Months	.3712	65.35
51/132	(2.6) 3 Months	.3864	76.01
52/132	(2.5) 3 Months	.3939	83.15
53/132	(2.5) 3 Months	.4015	57.87
55/132	(2.4) 2 Months	.4167	67.29
56/132	(2.4) 2 Months	.4242	66.52
62/132	(2.1) 2 Months	.4546	71.69
66/132	2 Months	.5000	284.38

Note: Only those frequencies that had a Sum of Squares larger than 40 were included in the table.

total sum of squares answer by the variance explained by the frequency of the annual cycle (5924.98/13789.87 = .4297).

The annual cycle was also significant for African-American students at the .05 alpha level (N = 135, critical value =.10452, r1 =.1180). R1 was calculated by dividing by the frequency of the annual cycle to the total Sum of Squares (310.41/2631.606 = .1180). The second largest variance for European-Americans that corresponded with a six month cycle was not statistically significant at the .05 alpha level (N = 135, critical value =.10452, r1 =.0435) (r2 = 600.11/13789.87 = .0435).

The second largest variance for African-Americans that corresponded with a two month cycle was statistically significant at the .05 alpha level (N = 135, critical value = .10452, r1 =.1081) (r2 = 284.38/2631.606 = .1081). The third largest variance for African-Americans that corresponded with the sixth month cycle was not statistically significant at the .05 alpha level (N = 135, critical value =.10452, r1 = .0979) (r3 = 257.52/2631.606 = .0979).

In sum, these data support the hypothesis based on visual inspection that there is an annual cycle of births for OHI students that occurred regularly over the 11 years of data analyzed. Further, a 2 month cycle was detected for African-American children.

Further Test of Hypothesis

The spectral analysis revealed that there was a reasonably consistent 12 month cycle in the birth frequencies of OHI students. However, this does not indicate that on an aggregated basis, the spring peak was significantly higher than other birth periods. Thus, the next step in the data analysis process was to determine if children with an OHI

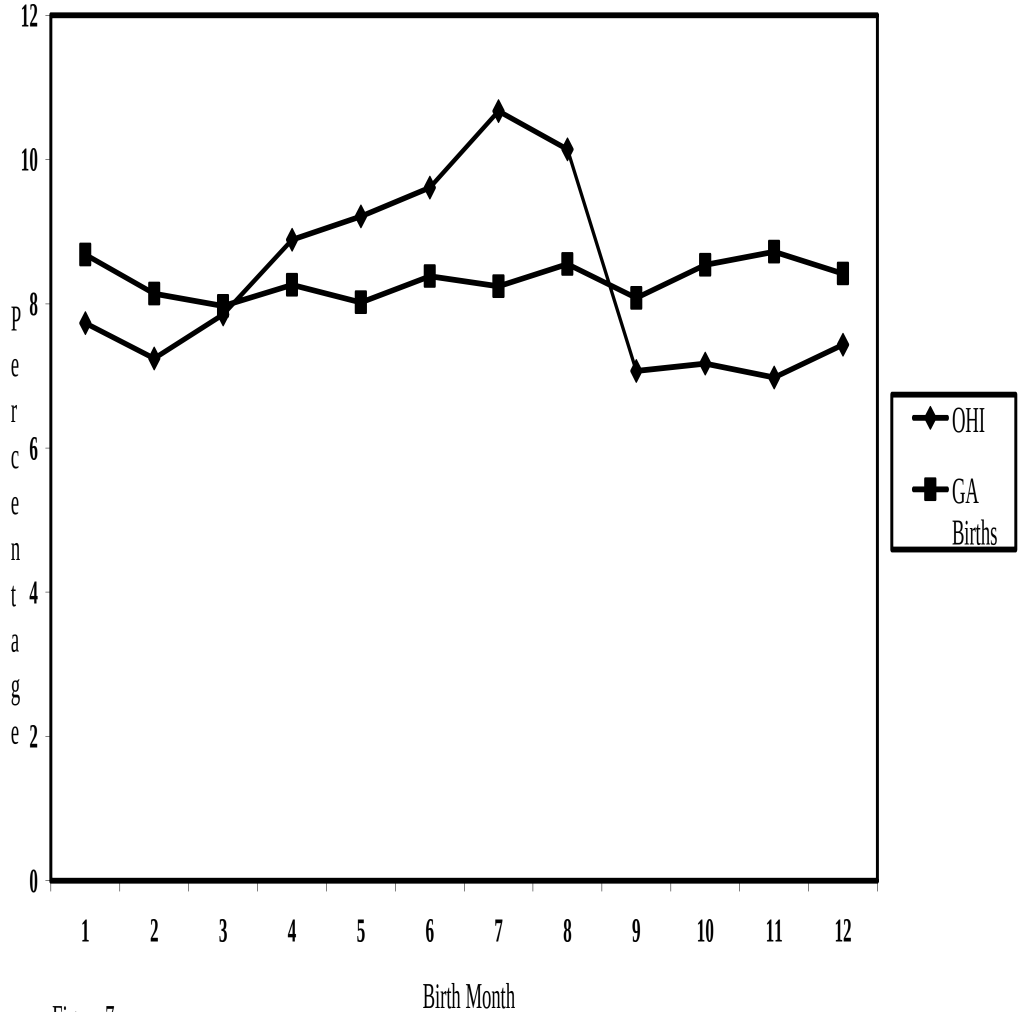

Figure 7

Percentage of Births Per Month for All Children Receiving Special Education Services for Other Health Impairment and Percentage of All Births Per Month for All Children in Georgia diagnosis were disproportionately born across birth months aggregated across all years of data.

When all data for students in OHI were combined (collapsed across race and gender, and birth year), it was determined that these students were born more frequently in the period May through August than in other months (see Figure 7). The lowest or nadir months of birth included the months October, November, and December. A chi square test of goodness- of-fit between expected and observed values across the 12 birth months revealed that there was a significant effect for birth month (Chi Square = 188.90; d. f. = 11; p < .0001).

In order to determine if this effect was moderated by other factors, birth patterns of OHI were compared across gender, location (rural, suburban, and urban), and ethnicity (European-American, African-American). The data analyzed are presented in Tables 15, 16, and 17. For each analysis, a chi square test of independence was used, applied to a 2 (male versus female, for example) by 12 (months of birth) contingency table with births per month serving as the dependent variable.

In order to determine if gender (boys and girls) moderated this relationship, the percentage of OHI children born per month for each gender was calculated. These data are presented in Table 15. It can be seen that the pattern of births was similar for males and females with a peak in April, May, June, July, and August and a nadir period in October, November, and December. A chi square test of independence indicated that gender was significant (Chi Square = 20.99: d. f. = 11; p = < .05). Thus, gender was a moderator for birth month.

Table 15

Monthly Birth Pattern of Children in OHI (Adjusted for Number of Days Per Month) by Gender: September 1984 – August 1995

Month of Birth	Male Frequency	Male Percentage	Female Frequency	Female Percentage	Total Frequency	Total Percentage
January	466	7.57	195	7.97	661	7.68
February	453	7.36	170	6.94	623	7.24
March	479	7.78	206	8.42	685	7.96
April	578	9.39	188	7.68	766	8.90
May	578	9.39	217	8.86	795	9.24
June	577	9.38	249	10.17	826	9.60
July	662	10.76	249	10.17	911	10.59
August	591	9.60	273	11.15	864	10.04
September	445	7.23	167	6.82	612	7.11
October	456	7.41	163	6.66	619	7.20
November	401	6.52	194	7.92	595	6.92
December	468	7.61	177	7.24	645	7.52

Table 16

Monthly Birth Pattern of Students in OHI (Adjusted for Numbers of Days Per Month) by Ethnicity/Race: September 1984 – August 1995

Month of Birth	European-American Frequency	European-American Percentage	African-American Frequency	African-American Percentage
January	487	7.51	174	8.18
February	455	7.03	168	7.90
March	540	8.34	145	6.82
April	572	8.83	194	9.12
May	636	9.82	159	7.48
June	602	9.30	224	10.53
July	694	10.72	217	10.20
August	642	9.92	222	10.44
September	472	7.29	140	6.58
October	461	7.12	158	7.43
November	435	6.72	160	7.52
December	479	7.40	166	7.80

Table 17

Monthly Birth Pattern of Children in OHI Living in Small Rural, Medium Rural, and Urban Counties (Adjusted for Number of Days Per Month): September 1984 – August 1995

Month of Birth	Small Rural Frequency	Small Rural Percentage	Medium Rural Frequency	Medium Rural Percentage	Urban Frequency	Urban Percentage
January	58	6.48	94	8.35	401	7.49
February	61	6.82	90	7.99	385	7.19
March	72	8.04	87	7.73	431	8.05
April	88	9.83	103	9.15	476	8.89
May	83	9.27	107	9.50	489	9.13
June	83	9.27	92	8.17	531	9.91
July	108	12.07	112	9.95	547	10.21
August	90	10.06	110	9.77	548	10.23
September	77	8.60	78	6.93	388	7.24
October	59	6.59	80	7.10	384	7.17
November	48	5.36	85	7.55	378	7.06
December	68	7.61	88	7.81	398	7.43

In order to help determine if ethnicity (European-American and African-American students) moderated this relationship, the percentage of OHI children born per month for each ethnicity was calculated. The analysis was limited to European-American and African-American students because the sample of the remaining ethnic groups was too small to provide a meaningful test. These data are presented in Table 16. A chi square test of independence indicated that ethnicity was significant (Chi Square = 23.50; d.f. = 11; $p < .05$). Thus, ethnicity was a moderator for birth month.

In order to determine if environment (small rural schools, medium rural schools, and urban schools) moderated this relationship, the percentage of OHI children born per month for each environment was calculated. These data are presented in Table 17. It can be seen that the pattern of births was very similar for small rural school, medium rural school, and urban school environments with a peak in April, May, June, July, and August and a nadir period in October, November, and December. A chi square test of independence indicated that environment (small rural, suburban, and urban) was not significant and it was not a moderator for birth month (chi square = 17.26; d.f. = 22; p = ns).

CHAPTER 5

DISCUSSION

Rationale for the Study

The current study focused on the issue of whether seasonal birth patterns exist for children who are receiving services in the Other Health Impaired (OHI) special education category. Although one study has been completed indicating season-of-birth effects for Attention-Deficit/Hyperactivity Disorder (ADHD) (between 80 and 90 percent of students in OHI have ADHD in the Georgia Public Schools) numerous questions regarding the possible effects of moderating variables such as gender, ethnicity, and environment on OHI diagnoses remain unanswered.

In the current study, the birth dates of 8, 602 children and adolescents who were receiving special education services in the OHI category were collected and analyzed to determine whether seasonal birth patterns were present. The demographic data available for the entire cohort were used to identify and examine the following potential moderating variables: gender (boys and girls), ethnicity (European-American, African-American, and Hispanic), and environment (small-rural, medium-rural, and urban). The study focused on four general questions: 1) Are greater numbers of children with an OHI diagnosis born during the spring and summer months than during the Fall and Winter? 2) Are the birth patterns of children diagnosed as OHI similar for the three ethnic groups (European-American, African-American, and Hispanic)? 3) Is the birth pattern for boys in OHI different from that of girls? 4) Is the pattern of births of students in the OHI special education category different in urban than in rural environments?

The results strongly supported the primary hypothesis. It was found that a disproportionate number of children who were receiving services through the OHI special education category were born during the late spring and summer months. Spectral analysis, a form of time-series analysis, statistically confirmed the significance of the disproportionate birth pattern across all years of the study, September, 1984 – August, 1995.

Interpretation of Results

Two hypotheses, the Prenatal Insult hypothesis and the Youngest in Grade hypothesis, have been postulated to explain the disproportionate spring and summer birth rate of children who have a number of different psychological or psychiatric diagnoses. The Prenatal Insult hypothesis advocates for a biological perspective, while the Youngest in Grade hypothesis proposes a social explanation for the disproportionate birth rate pattern.

The biological perspective emphasizes that the fetal brain grows rapidly during pregnancy and crucial developmental brain processes (neural proliferation, neural migration, and neural differentiation) occur while the fetus is still in the womb. Biological or environmental insults to the brain of the fetus during these crucial developmental processes will have different levels of detrimental effects varying by when the insults occurred during the pregnancy. Disruptions to neural proliferation during the first trimester of pregnancy (Months 1, 2, and 3) usually lead to stillbirth, infant death, or severe developmental disabilities (such as Mental Retardation). Insults to the neural migration process during the second trimester of pregnancy (Months 4, 5, and 6) usually lead to less severe manifestations of behavioral or developmental disabilities (Orthopedic Impairments, ADHD, etc.).

The season in which the insult to the fetus's brain occurs is also significant from this viewpoint. Women who are pregnant during the winter months may have a greater chance of contracting a viral infection than their peers who are pregnant during the summer. The Prenatal Insult hypothesis assumes that the fetus's brain is damaged for most of OHI cases during the second trimester of pregnancy. The second trimester of pregnancy occurred during the winter months for children born in the spring and summer months which increased the mother's likelihood of having a viral infection during this critical period. Other damaging events have been postulated including maternal vitamin D deficiencies during the later winter, and seasonal patterns of air pollution.

The Youngest in the Grade hypothesis advocates for a social explanation of the finding that more children in OHI are born during the spring and summer months. The Youngest in Grade hypothesis notes that the September 1st cutoff date for school systems in Northeast Georgia has the result that children born in the late spring and summer months are youngest in their grade. They are the most biologically and socially immature on average. Thus, the Youngest in Grade hypothesis states that the most immature children would be referred more often for psychological assessment by teachers particularly for conditions that relate to a lack of self-regulation. Thus, with more referrals for special education evaluations given to spring and summer born children, there is a tendency for more children in the spring and summer to be diagnosed with disorders that receive services under the OHI special education category.

This study does not provide definitive evidence to differentiate among these hypotheses. However, inspection of the data does provide a few clues. The Youngest in Grade hypothesis emphasizes that the youngest children in the grade, those children born during the summer months (June, July, and August) are referred more often for special education services. Children who are born in August are the youngest of the young children in the grade under the current September 1st cutoff date. If the Youngest in Grade hypothesis were valid then it would be expected that August would have the highest number of OHI births. The European-American and African-American data reveal that although children in the OHI special education category are born at a disproportionate rate during August, there are higher disproportionate peaks of OHI births during April, May, June, and July. Thus, the role of the Youngest in Grade hypothesis is somewhat weakened by the earlier peak.

Practical Considerations

Combining thoughts from both hypotheses raise particular concerns. Children born during the spring and summer months may be at a greater biological risk of developing less severe forms of developmental and behavioral disabilities and they are at a greater risk of receiving a diagnosis warranting special education due to their youth and immaturity. The combination of greater biological risk and perhaps greater social risk for inclusion in special education for children born during the spring and summer months leads to questions about the validity of the current September 1st cutoff date for school entry.

An alternative to the September 1st cutoff date for school entry would be to push the cutoff date for school entry back to January 1st. This would mean that the late spring and summer born children would no longer be the youngest and most immature children in the grade. If the Prenatal Insult hypothesis were valid then the spring and summer born children would still have biological risks. If schools had a January 1st cutoff date for school entry, it is possible that their would continue to be a disproportionate number of late spring and summer births for children in OHI, and it is also possible that the Prenatal Insult Hypothesis could account for these births. Additionally, with a January 1st cutoff date for school entry the Youngest in the Grade Hypothesis would predict that a peak of births would occur during November and December for children in OHI since November and December born children would be the youngest students in the grade.

Strengths and Limitations of the Study

The current study addressed research questions using a very large sample size. This sample size (8, 602 children and adolescents) was much larger than the only other published study (Mick et al., 1996) involving seasonal birth patterns and ADHD. The study also examined the potential moderator variables of gender, ethnicity, and environment. Mick et al.'s study did not incorporate the environment of the children in their study. By examining the prevalence of OHI in certain environments (small rural, medium rural, or urban) by month this strengthened the generalizability of this study's findings. The Mick et al. study researched only European-American males and females. The current study included European-Americans and African-Americans. This range of ethnicities also contributes to an increased generalizability of the findings from this study.

Because of the small populations of minority groups other than African-Americans in Georgia, sufficient data were not available to study other ethnic groups

(Hispanics, Asian-Americans, Pacific Islanders, etc). Thus, expansion of this type of research to other ethnic groups would be helpful.

Because the study used data collected from northern Georgia, the results of this study may not be directly applicable to other regions of the United States or to other regions of the state of Georgia. This study did not examine seasonal birth patterns in specific diagnoses within the broad OHI domain (e.g. diabetes, cerebral palsy, ADHD). Further, this study did not distinguish between the primary and secondary diagnoses of the children and adolescents in the OHI sample in the special education data set. Comorbidity is the rule rather than the exception in childhood mental illness, so it would have been helpful to acquire the primary and secondary diagnoses for children and adolescents in the OHI special education category.

Suggestions for Future Research

Future research should attempt to determine if the 2nd trimester perturbations are associated with later development of OHI and ADHD in childhood or adolescence. Longitudinal research is needed to follow the child from fetal development through adulthood. By tracking the child from pregnancy into adulthood, researchers can make causal assumptions and conclusions about hypotheses that were tested throughout the study period. Research should also examine the differences in birth rates per month for OHI disorders in school districts that have September 1st cutoff dates versus school districts that have their cutoff dates later or earlier in the year. By examining these birth rates across different cutoff dates the researcher will be able to determine whether or not the youngest children in the grade are being referred more often and diagnosed more often for special education services. Future research should also track season-of-birth patterns in other states in the United States, and a season-of-birth analysis that involves other countries throughout the world would be beneficial. Replicating this study in other states and countries is important because variables such as climates, altitudes, length of seasons, etc. are different in diverse regions of the country and the globe. Further, maternal exposure rates to viruses vary based on such variables as population density, family crowding, and sophistication of health care.

Future research should examine if seasonal birth patterns exist with the symptoms of ADHD (inattention, hyperactivity, and impulsivity). Determining a seasonal birth pattern for symptoms of ADHD would be significant because other disorders share some symptoms (inattention and depression) with the symptoms of ADHD. Comorbidity between disorders should be examined with their seasonal birth implications. Other disorders may account for some of the spring and summer disproportionate birth rate pattern for children in the OHI special education category.

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APPENDIX A

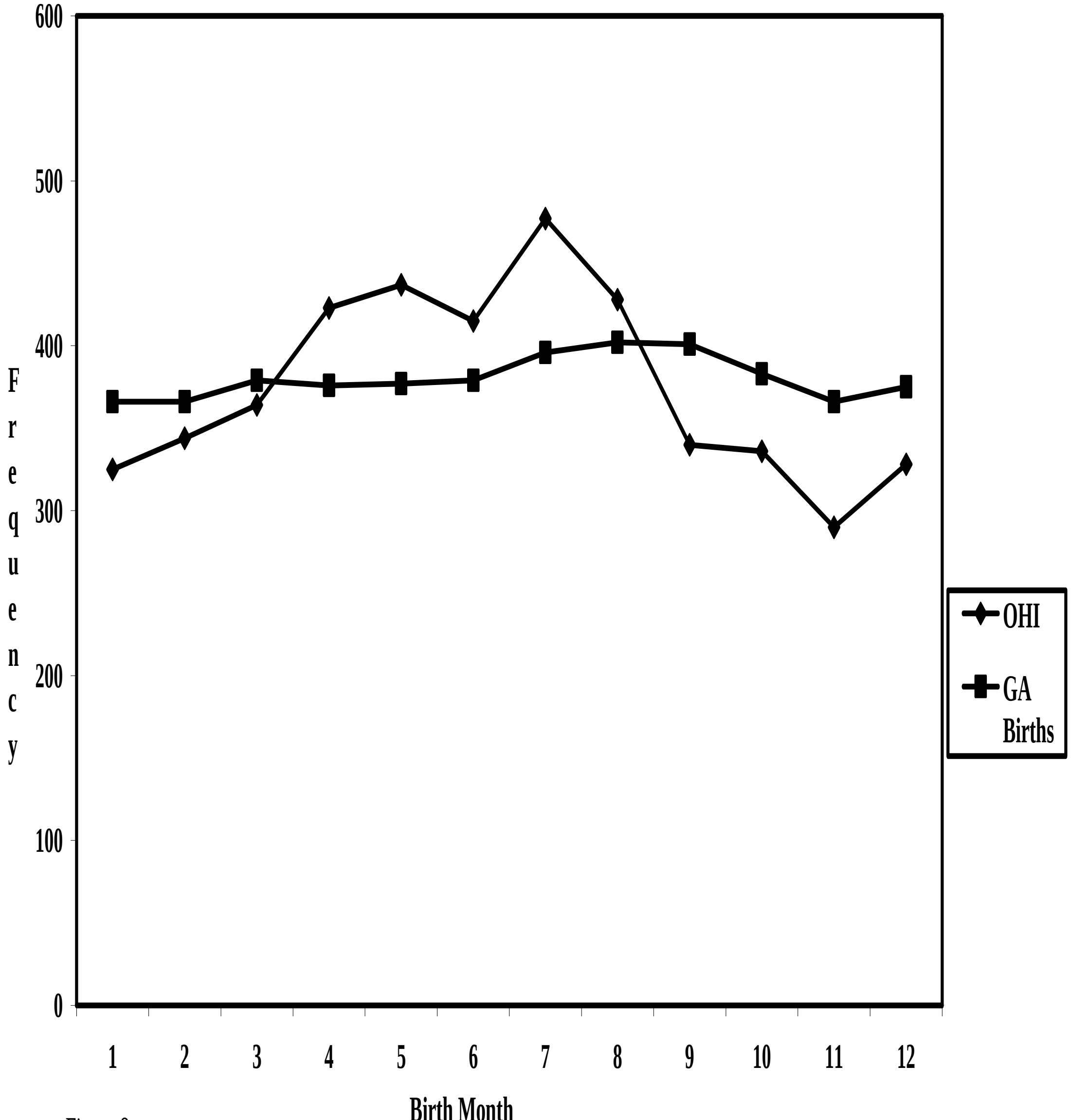

Figure 8

Frequency of Births Per Month for European-American Male Children Receiving Special Education Services for Other Health Impairment and All Births of European-American Children in Georgia

APPENDIX B

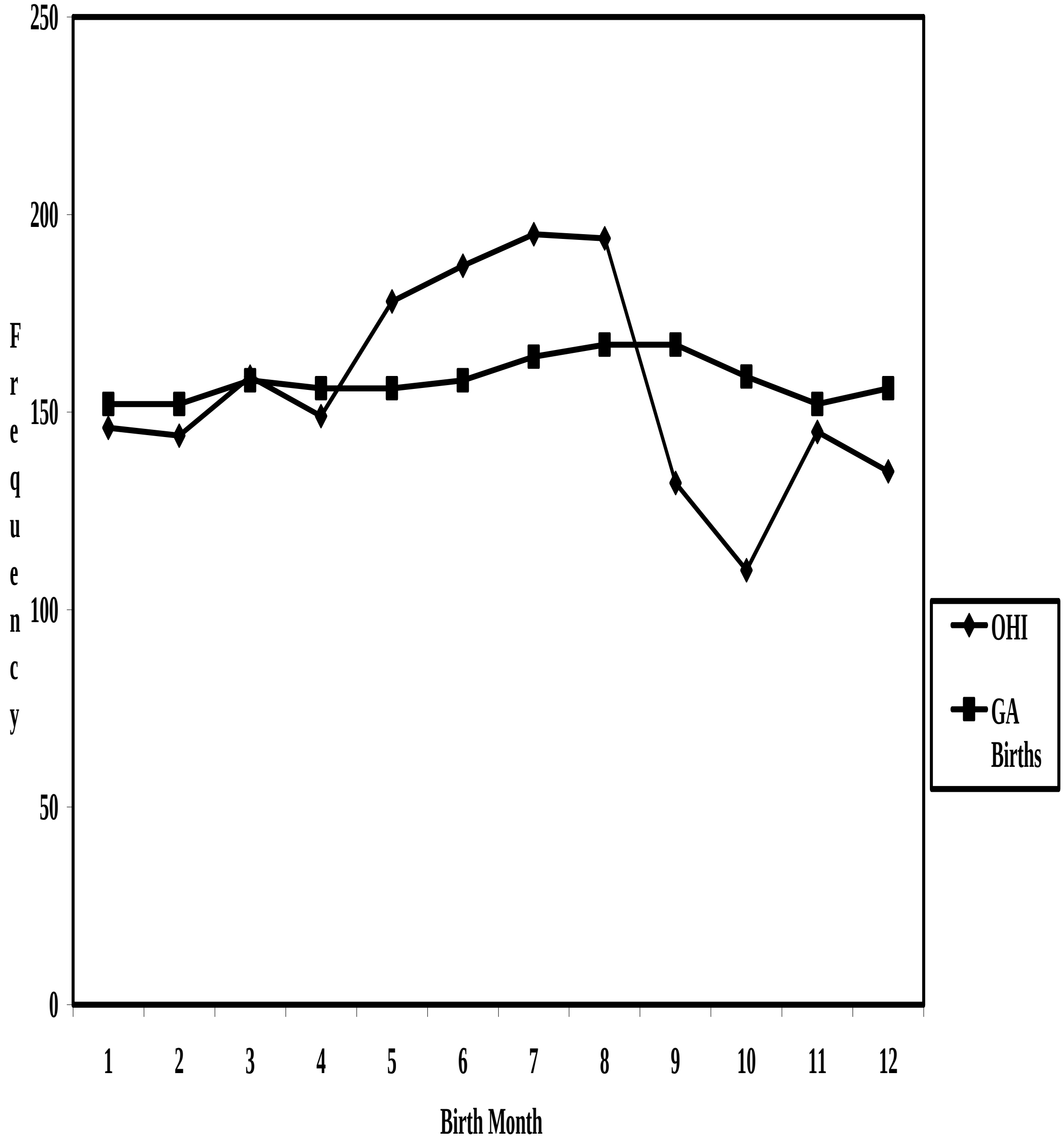

Figure 9

Frequency of Births Per Month for European-American Female Children Receiving Special Education Services for Other Health Impairment and All Births of European-American Children in Georgia

APPENDIX C

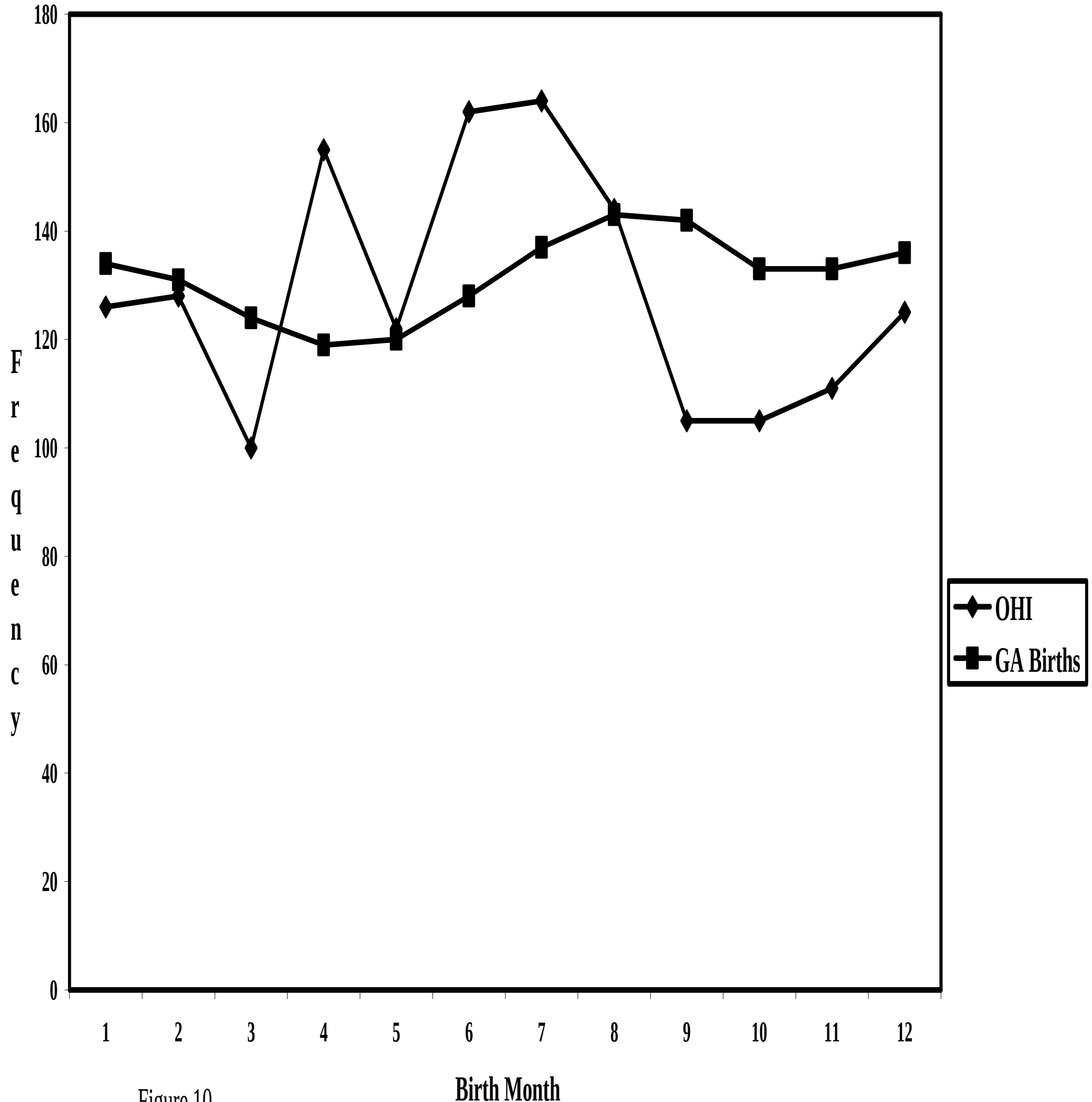

Figure 10

Frequency of Births Per Month for African-American Male Children Receiving Special Education Services for Other Health Impairment and All Births of African-American Children in Georgia

APPENDIX D

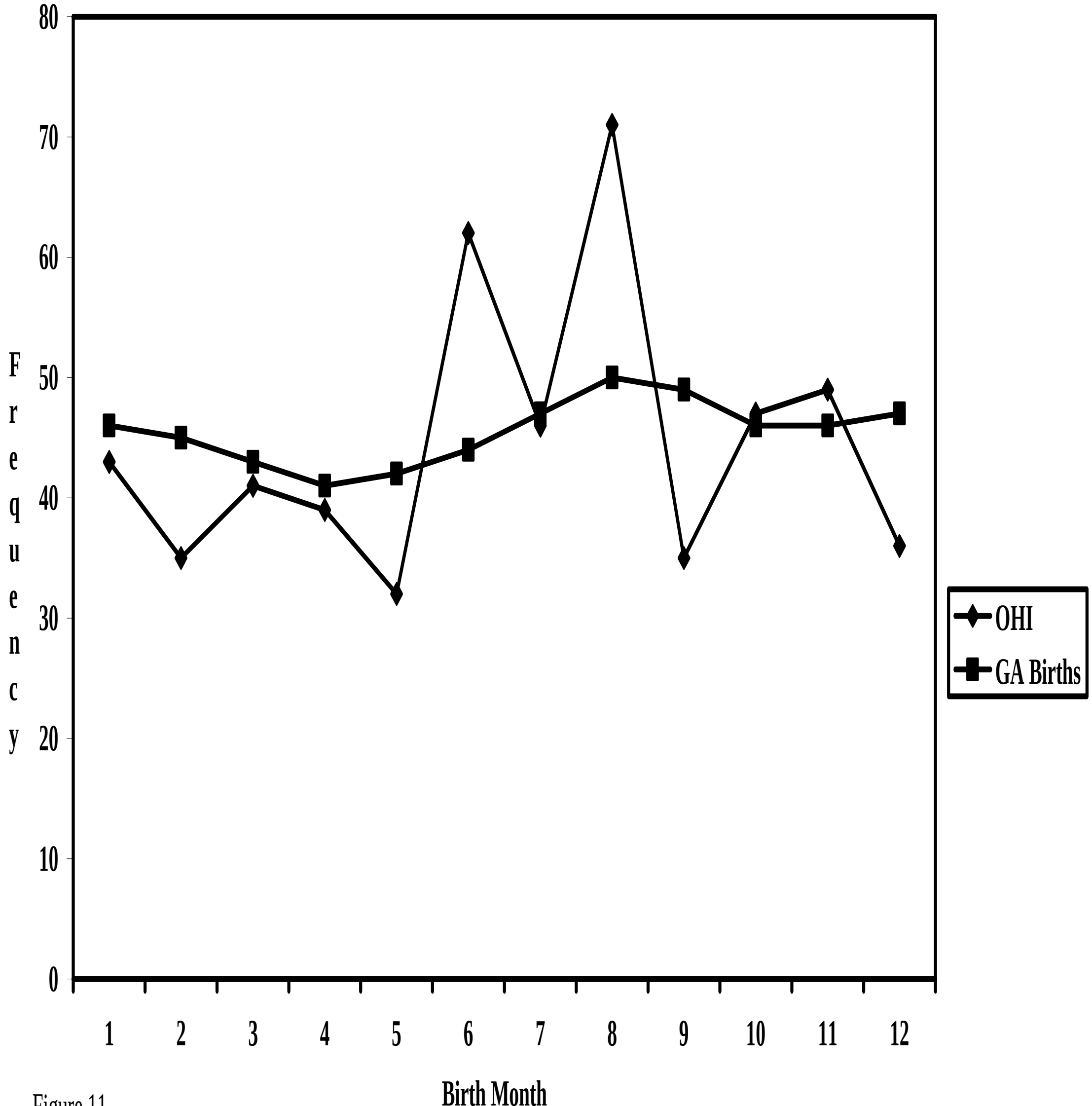

Figure 11

Frequency of Births Per Month for African-American Female Children Receiving Special Education Services for Other Health Impairment and All Births of African-American Children in Georgia