SEASONAL PATTERNS OF PERINATAL ANOMALIES

by

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(Under the direction of Randy W. Kamphaus)

ABSTRACT

This study examined the relationship between season-of-birth and groupings of six perinatal anomalies for white and black births in Georgia between 1991-2002. This research builds on past studies that examined season-of-birth effects for schizophrenia, learning disabilities, mental retardation, and behavior disorders. The perinatal anomaly data were obtained from the Natality Data Set issued by the National Center for Health Statistics (NCHS) under the auspices of the Center for Disease Control and Prevention of the Department of Health and Human Services.

It was postulated that monthly anomaly birth rates would be meaningfully greater than the anomaly's average monthly birth rate during the late winter and summer months. It was also postulated that monthly anomaly birth rates would be the same for white and black infants. Last, it was postulated that the pattern of birth rates for each anomaly would occur in significant cycles of 3, 4, 6, or 12 months.

White and black infants with low and middle range Apgar scores, white and black infants born at very low birth weight, and black infants born requiring artificial ventilation demonstrated meaningful monthly birth rate peaks that occurred in either the late winter (February) and/or spring/summer months (April-July). Not all perinatal anomalies exhibited meaningful monthly birth peaks. Significant 12 month birth rate cycles were found for black infants born at very low (less than 1500g) birth weight, black infants born at normal-high (greater than 2500g) birth weight, white infants born with other complications at delivery, and black and white infants receiving ventilation at less than 30 minutes after delivery. A significant 6 month cycle was found for white infants assigned middle range Apgar scores. Not all anomalies demonstrated significant birth rate cycles.

INDEX WORDS: Season-of-Birth, Apgar Scores, Ventilation, Fetal Distress, Other Complications of Delivery, Birth Weight, Breech Birth Delivery

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DEDICATION

For Whitney

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CHAPTER 1

INTRODUCTION

A great deal of research focuses on identifying the etiological factors that explain why some people are more likely to acquire psychopathology than others. Identifying possible risk factors of pathologies allows intervention to occur earlier in development, hopefully before a person's life is severely impacted. Despite significant effort and some progress, however, the factors predisposing persons to many forms of psychopathology remains obscure. Current theories on risk factors of psychopathology place most emphasis on genetic and postnatal environmental factors. In other words, it's a combination of one's genes and one's upbringing that influence the chances of developing pathology.

The central nervous system begins to develop very early after conception. Therefore, the prenatal and perinatal periods of development may be of profound importance in understanding human pathology. The central nervous system (CNS) is at the heart of the biological-environmental interaction; the CNS is influenced by the person's genetic heritage and the environmental circumstances to which it is exposed, particularly during the period of most rapid growth (the prenatal period). When the CNS is damaged in the prenatal environment, developmental irregularities may occur which can lead to abnormal CNS functions. For example, morphological and biochemical mechanisms may be disrupted when the CNS structure is damaged during early stages of prenatal development.

Embryologists who have studied environmental risks to fetal development originally used the term "teratogen" to denote any prenatal disturbance that causes the development of grossly abnormal or deformed offspring. This definition has been expanded in the research literature to refer to traumatic events or other entities that promulgate developmental problems of the nervous system (Mayes & Ward, 2003). These problems may lead to neurobehavioral disorders, including psychopathology.

The effects teratogens have on development are regulated by the intensity (physical force, radiation dose, maternal blood alcohol level, etc.), duration (repeated, persistent, momentary, etc.), form (toxin, mechanical trauma, malnutrition, etc.), and time of incidence during the developmental process (Mayes & Ward, 2003). Teratogenic insults may result in such significant effects as organism death and gross malformation, or have less severe consequences including mental retardation and other developmental delays.

In general, prenatal development is thought to be genetically determined (Anderson et al., 2001). Developmental interruptions during the prenatal period from perturbations such as intrauterine trauma or infection can significantly affect cerebral structure to the point that the morphology of the brain appears abnormal even at a macroscopic level (Anderson et al.). In terms of outcomes of teratogenic exposure, it is commonly held that outcomes from high intensity, long duration, teratogen exposure are easily observed and related to the source of the exposure. However, outcomes from lower intensity or shorter duration teratogenic exposure may yield understated and less distinguishable effects.

Anderson et al. (2001) have concluded that the vulnerability of the CNS during prenatal development is greater than after birth; the CNS is more susceptible to the harmful effects of trauma or exposure to environmental variables (e.g. malnutrition, radiation, toxins, etc.) during certain critical, prenatal periods of development when the organism is developing rapidly. Mayes and Ward (2003) found also that the timing of an insult to the CNS is a major factor in determining the type and degree of any ensuing alteration of neural development.

One class of environmental events that has been shown to relate to human pathology are those events mediated by season-of-birth. The time of year a person is born, or one's season-of-birth, has been shown to influence one's predisposition towards developing certain pathologies later in life. This type of research includes the study of weekly and monthly birth patterns in addition to seasonal ones (Martin et al., 2004).

Since the early 20th Century, researchers have found that persons with a variety of pathologies have birth patterns that are significantly different than those of the general population (Barry & Barry, 1931; Dalen, 1975). Perhaps most famously, over 200 studies have demonstrated that schizophrenics are born in the late winter and early spring with consistently greater frequency than the general population (Barr, Mednick, & Munk-Jorgensen, 1990; Castrogiovanni et al., 1998; McGrath & Welham, 2002; Takei e al., 1995). At present, a variety of disorders have been linked to seasonal birth patterns including: autism, glaucoma, allergic sensitization, asthma, allergic rhinitis, and menstrual disorders (Castrogiovanni et al., 1998). Even cognitive pathologies such as specific learning disabilities and reading disorders have demonstrated seasonal birth patterns (Castrogiovanni et al., 1998; Martin et al., 2004).

Typically, season-of-birth studies examine how annually occurring environmental factors negatively affect prenatal development, particularly that of the central nervous system. For example, maternal viral infections, which occur more frequently during the winter months, can have detrimental effects on the developing central nervous system. Measles and cytomegalovirus infections, both of which are capable of causing fetal damage, have a seasonal incidence. Thus, these viral infections could be linked to later psychopathology (Mick et al., 1996).

It is important to recognize the current scope of season-of-birth research; the study of the season-of-birth phenomenon is not composed of a few isolated researchers and studies. Rather, the relationship between season-of-birth and the risk for psychopathology has been examined in dozens of countries and there are currently a large number of published studies considering this association (Castrogiovanni et al., 1998).

Despite this body of research, however, the prenatal, biological, causal mechanisms that contribute to the season-of-birth phenomenon are still unclear. This study seeks to clarify some aspects of the season-of-birth phenomenon by studying seasonal patterns in perinatal events that are likely to result in less than optimal CNS development. In other words, negative perinatal outcomes such as fetal distress, low Apgar scores, and the need for artificial ventilation following delivery suggest that the infant was subjected to some significant prenatal insult. If these events have a seasonal component, then a possible link has been made between seasonally occurring prenatal environmental insults and human pathology.

Purpose

The proposed study will build on the season-of-birth literature by determining if birth patterns of specific groupings of six perinatal anomalies recorded for Georgia births display meaningful monthly variations. At this time, it seems important to discuss what this study considers to be a “meaningful” variation in monthly birth rate. The vast majority of season-of-birth research considers deviations between 5%-10% from the mean to be meaningful. This study considers rates more than 8% from the total monthly mean to be meaningful birth variations. In other words, monthly peaks greater than 8% above the mean and nadirs more than 8% below the mean are considered “meaningful monthly variations.”

All natality data and associated variables were obtained from the Natality Data Set issued by the National Center for Health Statistics (NCHS) under the auspices of the Center for Disease Control and Prevention of the Department of Health and Human Services. The analyses will individually examine monthly birth distributions for infants who at birth were designated as having experienced: breech birth delivery, fetal distress, other complications of labor and/or delivery, ventilation less than 30 minutes following delivery, ventilation after 30 minutes of delivery, very low, low, and normal-high birth weight, and 5 minute Apgar scores in the low, middle, and high range.

There are three specific questions that this study will address: 1) are there meaningful monthly variations in birth patterns for any of the groups of perinatal anomalies and when did these variations occur, 2) are the variations the same for white and black infants, and 3) did these monthly variations occur in significant cycles of 3, 4, 6, or 12 months?

It is hypothesized that analysis of the monthly birth rates of the groups of perinatal events will reveal two meaningful peaks: late winter (February/March) and summer (June, July, and August). Also, it is hypothesized that anomaly birth rate peak and nadir periods for Caucasian (heretofore referred to as “white”) and African-American (heretofore referred to as “black”) will be similar. Last, it is hypothesized that anomalies with meaningful birth rate peaks and nadirs will occur at significant cycles of 3, 4, 6, or 12 months.

CHAPTER 2

REVIEW OF THE LITERATURE

The purpose of this chapter is to review the most pertinent literature in the areas most relevant to this dissertation. These areas include: season-of-birth, hypothesized causes of season-of-birth, and perinatal factors that may predict season-of-birth.

Season-of-birth

"Season-of-birth" in the context of medical or psychosocial research is the term used to describe the theory that children born during a given season may be disproportionately at risk for certain pathologies or for developing behavioral problems later in childhood or adult life. This type of research includes the study of weekly and monthly birth patterns, in addition to seasonal ones. Since the early 20th Century, researchers have found that persons with a variety of pathologies have birth patterns that are significantly different than the general population (Barry & Barry, 1931; Dalen, 1975). Perhaps most famously, over 250 studies have demonstrated that schizophrenics are born in the late winter and early spring with consistently greater frequency than the general population (Barr, Mednick, & Munk-Jorgensen, 1990; Castrogiovanni et al., 1998; McGrath & Welham, 2002; Takei et al., 1995).

Further investigation of the literature reveals that other pathologies are also subject to seasonal effects. Allergies are a case in point. One study, using a sample of 19,814 children born in 1963, found that children with allergy rhinitis and pollen allergies were born with greater prevalence in the early winter to late spring (Aberg, 1989). In addition, researchers in New Zealand looked at whether season-of-birth was associated with increased diagnosis of cat allergies. After looking at birth cohort of 1,037 children, they found that while socioeconomic status, position in family, and birth weight were not associated with any kind of allergy related problems, those born in the winter had a disproportionately greater sensitivity to cats and dust mites than children who were born in other months (Sears et al., 1996). Through a longitudinal study that followed 209 children from birth to 12-15 years of age, researchers in Sweden found that those born in fall through early winter were disproportionately at risk for developing allergies to milk and egg whites (Nilsson et al., 1996). These results supported the findings of a Dutch study which examined similar allergies of 78,000 children and found a similar increased risk for those born between September-February (Aalberse et al., 1992).

Most research on seasonal or monthly variations in birth patterns has focused on psychiatric or neurological diseases in adults. In addition to schizophrenia, season-of-birth has been found to be associated with multiple sclerosis, epilepsy, panic disorder, anorexia, Bipolar Disorder, suicide, and alcoholism.

Multiple sclerosis (MS) is a chronic, frequently disabling disease that affects the central nervous system. A study involving those diagnosed with MS in Denmark found that MS patients had an excess of births in the spring and early summer months of March, April, May, and June (Templer et al., 1992). The study pointed out that this exceptional birth pattern differed significantly from that of the general population. In addition, Sadovnick and Yee (1994) found a similar birth pattern for those with MS living in Canada.

Researchers in Sicily were interested to find out if people diagnosed with MS living in their region would exhibit the same birth pattern as was found in Denmark and Canada. To this end, birth patterns of 965 people in Sicily diagnosed with MS were analyzed and compared with that of the general Sicilian population of over five and one half million people. They found that more people with MS were born than would have been expected in the months between June-November. The researchers concluded that the Sicilian MS season-of-birth pattern was different than that found in both Denmark and Canada, perhaps due to the latter two countries' similar northern latitudes and ecological characteristics (Salemi et al., 2000).

According to the National Institutes of Health, epilepsy is a brain disorder in which groups of nerve cells, or neurons, in the brain occasionally signal abnormally. In epilepsy, the normal pattern of neuronal activity becomes disturbed which can cause strange sensations, emotions, behavior, convulsions, muscle spasms, and loss of consciousness. Puri (1995) found that there was a birth pattern trend for those born in December-March not to develop epilepsy.

Multiple sclerosis and epilepsy are neurological maladies in which psychosocial or psychological symptoms, if present, are secondary to the primary diagnosis. However, the majority of season-of-birth studies have focused on illnesses in which psychological manifestations are primary. For example, Panic Disorder (PD) is a pathology through which a person experiences recurrent panic attacks that are not due to effects of substance abuse and not better accounted for by another mental pathology (DSM-IV-TR). In an effort to identify a seasonal birth pattern for PD, one study compared the birth dates of 843 patients diagnosed with PD with the birth dates of 1,181 diagnosed with other pathologies. Both birth pattern samples consisted of outpatients registered with the Department of Psychiatry of Siena University and were compared with the birth patterns of the general Tuscan, and overall Italian population. Results indicated that those diagnosed with PD were born with significantly greater frequency in the months between September and December (Castrogiovanni et al., 2002).

Anorexia nervosa is an affective pathology which is categorized by a person being unable to maintain appropriate body weight, having a strong fear of becoming fat, using one's body weight as a measure of self-evaluation, and, if a woman, missing three menstrual cycles in a row (DSM-IV-TR). To investigate if patients diagnosed with anorexia nervosa were born with unexpectedly greater frequency during certain times of the year, researchers in Northeast Scotland examined case records of 446 females who were diagnosed with the pathology between 1965 and1997. This sample was compared with the birth pattern of 5,766 control subjects born in the following years: 1951, 1961, 1971 and 1981. The researchers found that patients with anorexia nervosa exhibited a birth peak in the late spring and early summer, specifically the months of March through June (Eagles et al., 2001). These results were similar to the findings of Morgan et al. (1998) who also found a specific March peak for those diagnosed with anorexia nervosa.

Bipolar I and Bipolar II are affective disorders that involve a person experiencing forms and combinations of extremely elevated and depressed moods

(DSM-IV-TR). Rihmer (1980) investigated if Bipolar I and Bipolar II populations had disproportionate birth patterns, and if so, if they had similar birth peaks. Rihmer analyzed the birth patterns of 50 Bipolar I and 42 Bipolar II females and found that females diagnosed with Bipolar I were born with greater frequency during the spring and fall, whereas Bipolar II patients were born with disproportional frequency in the summer and winter. In addition, results found that Bipolar I patients were hospitalized for mania more frequently in the spring and fall and for depression in the summer and winter. Rihmer concluded that there were different birth patterns among those who had been diagnosed with Bipolar I and Bipolar II.

Season-of-birth research has even been used to determine birth trends in victims of suicide. For example, Chotai, Renberg, and Jacobsson (2002) looked at data from all completed suicides between 1952 and 1993 in Vasterbotten County in northern Sweden to see if any significant birth patterns emerged in relation to suicide method and sociodemographic variables such as age. They found that among the sample of 1,466 suicides, those with a suicide age less than 45 years old were more likely than older suicides to have been born between February and April. In addition, those who chose hanging as their suicide method over poisoning or petrol gases were also more likely to have been born between February and April. However, those who chose the suicide method of poison rather than hanging themselves were shown to have been born with significantly greater frequency between October and January. Chotai et al. noted that these results were “somewhat more pronounced” for males than females.

It is generally accepted that risk factors for abusing and depending on alcohol include genetic predisposition and environmental variables. However, research was undertaken to determine if alcoholism, alcohol abuse, or alcohol dependence were further influenced by seasonal birth affects. Using data from the 1992 National Longitudinal Alcohol Epidemiological Survey, researchers were able to ascertain the birth dates of 42,862 men and women, all with varying degrees of alcohol dependency. Logistical regression analysis indicated fewer winter births for men with histories of alcohol dependence and disproportionately greater birth frequency in fall for male alcoholics. In addition, both men and women with histories of illicit drug use were disproportionately born with greater frequency in the fall than would have been expected given normal birth patterns (Goldberg et al., 2000).

Few studies have looked at seasonal variation in birth patterns of children who have neurological, psychiatric, or learning related pathology. However, seasonal or monthly variation in birth patterns have been found in children with autism, downs syndrome, dyslexia, specific learning disabilities, and attention-deficit hyperactivity disorder. Seasonal variation in birth patterns have even been found among children who exhibit excessive risk taking and novelty seeking.

Autism and autism spectrum disorders are characterized by variable degrees of impairment in communication skills, social interactions, and restricted, repetitive and stereotyped patterns of behavior (DSM-IV-TR). Several researchers have found seasonal effects for autism and autism spectrum disorders. For example, researchers in Boston wanted to determine if children with autism were born with greater than expected frequency during certain times of the year. They found that children in their cohort of 37 were born in disproportionately greater numbers in March (Stevens et al., 2000). In another study, researchers in Israel found that 188 children with autism born between 1964 and1986 were born in March and August at rates greater than expected (Barak et al., 1995). These results corroborated the findings of a study which looked at the birth patterns of 328 autistic children in Denmark and found an excess of March births, although only for males (Mourisden et al., 1994).

Several studies have found no seasonal pattern among those diagnosed with autism. For example, Yeates-Frederick (2000) investigated a sample of 1,031 patients with a diagnosis of infantile autism and found no evidence of a deviant birth pattern. In addition, Landua, et al. (1999) found no evidence to suggest a significant March and August birth peak among individuals with autism. Hultman (2002) examined the birth patterns of 408 children diagnosed with infantile autism and found no association between autism and season-of-birth.

Down Syndrome is a chromosomal abnormality resulting from an extra copy of the 21st chromosome. Researchers in London noted that previous season-of-birth studies involving children diagnosed with Down Syndrome found that these children are more frequently born in the summer months. However, they wanted to investigate if the same pattern emerged when studying the birth frequencies of adults diagnosed with Down Syndrome. These researchers found that adults with Down Syndrome were also disproportionately born during the summer, while only 6% of births took place during January and February compared with an expected percentage of 17% (Korenberg et al., 1990).

Research is also demonstrating that some learning based pathologies are influenced by seasonal birth patterns. For example, researchers at the University of Arkansas investigated whether there were season-of-birth effects for children diagnosed with dyslexia. An examination of 585 male children with dyslexia found a higher than expected birth frequency for the months of May, June, and July. When divided into 5 year birth cohorts, these same months accounted for 24-71% of the dyslexia cases (Livingston, 1993).

Martin et al. (2004) conducted a comprehensive study to investigate season-of-birth effects for children diagnosed with specific learning disabilities (SLD), their retention rate, and their overall academic achievement. Previous studies have found associations between season-of-birth and learning disability (LD) diagnosis. However, Martin et al. noted that they had not compared this association with levels of achievement or schooling outcomes. In his study, Martin et al. compared the standardized achievement scores and rates of SLD diagnosis for children born during each season. The sample consisted of 2,768 white children born between 1984-1990 who were receiving special education services in one of 28 pubic school districts in northeast Georgia. As was found in previous studies, Martin et al. found that children born in the months of June, July, and August were more frequently diagnosed with SLD than was expected. In addition, the study found also that children born in those months performed consistently lower on measures of reading, science, and mathematics achievement. Lastly, Martin found that approximately 25% of the children born in the summer months were retained or held back from entering the following academic grade, a much higher rate than for other months.

Based on findings of a season-of-birth component for specific learning disabilities (SLD), further research was conducted by Martin (2006) to determine if speech and language impairment (SLI) was related to season-of-birth, as SLIs are often related to learning disabilities. Speech-language impairment (SLI) is a special education classification used to describe a child who has a communication skill that is significantly weaker than all of his or her other communication skills. This communication skill must be so weak as to disrupt communication or affect emotional, social, intellectual, or educational growth. SLI may be congenital or acquired and involve articulation, language, fluency, and/or voice impairments. Martin (2006) found that children in Georgia with SLI were born at significantly greater than expected rates in the months between May-August.

In an additional extension of this research, Martin (2006) investigated the major categories of mental impairments (mild, moderate, severe, and profound). Mild and moderate mental impairments did not have a season-of-birth component. However, the more severe types of mental impairments were related to season-of-birth. Although the demarcations vary depending on the assessment given, in general, severe mental impairment refers to persons whose intellectual functioning ranges from an upper limit of 40 to a lower limit of 25, while profound intellectual impairment refers to persons with an IQ of 25 or below. In addition, persons with severe or profound mental impairments typically demonstrate deficits in adaptive behavior that significantly limit their ability to meet standards in maturation, learning, independence, social responsibility, and school performance. Martin (2006) found that among children in Georgia's special education population from 1991-2001, those with severe and profound mental impairments were born at a rate significantly greater than expected during the months of March and April.

Greer (2004) investigated whether children with various internalizing problems such as anxiety, depression, somatization, and withdrawal demonstrated a seasonal variation in their birth patterns. Greer analyzed ratings from teacher reports of student behavioral adjustment on the Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1992). After examining the four scales plus an overall Internalizing Problems Composite score, Greer found that children who were seen by teachers as exhibiting significant levels of anxiety were born at greater than expected rates in the spring/summer. In addition, Greer found that those children with significantly elevated overall Internalizing Composite scores were also born disproportionately in the spring and summer as well.

Mick et al. (1995) investigated whether children with attention-deficit/ hyperactivity disorder (ADHD) were born with greater frequency during certain times of the year. Although he did not find an effect for season-of-birth and ADHD, he did find significant effects for September births for children who were diagnosed with both ADHD and a learning disability. He also found a disproportional September birth rate for children with ADHD without psychiatric comorbidity. Mick concluded that there might be a season birth pattern for subtypes of ADHD, if not for ADHD itself.

In summary, the best evidence currently available indicates that most severe psychopathologies tend to have a late winter/early spring birth peak (autism, schizophrenia, severe/profound mental impairment). Less severe psychopathologies (specific learning disability (SLD), speech/language impairment (SLI), internalizing problems, dyslexia) tend to have a summer birth peak. While this general rule is a good start, it is important to note that not all studies find these psychopathologies to have such birth peaks. For example, Korenberg et al. (1990) found that Downs Syndrome births occurred with greater frequency during the summer months, not the late winter/early spring; most would consider Downs Syndrome a severe psychopathology. In addition, Konstantareas et al. (1986) found a more vague "spring and early summer" birth peak for non-functioning male autistics; they did not find the specific peak in March as was found by the other studies mentioned in this paper. Lastly, Bolton (1992) found no significant birth pattern among a clinical sample of autistics.

Causes of Season-of-birth

There are numerous hypotheses used to explain the causes of the season-of-birth effects for the pathologies discussed: maturity of the child, the child's self concept, maternal infection, maternal vitamin D deficiency, birthweight, the child's play environment, level of serotonin and endocrine production, and average rainfall during gestation just to name a few.

Maturity, Self-Concept, Infection, and Vitamin D Hypotheses

Martin et al. (2004) cited four commonly held hypotheses to explain why children born in the summer seem to be more at risk for learning disabilities and other cognitive and emotional disabilities: maturity hypothesis, self-concept hypothesis, gestation infection hypothesis, and gestational vitamin D hypothesis.

A seemingly intuitive explanation for why children born in summer are at greater risk for learning based pathologies is the maturity hypothesis. Most schools in the United States have a September cut-off for school entry. Therefore, those born in the summer months (up to August 31) are the youngest in their grades. As a result, these children's brains are the least developed, specifically in the realms of self-regulation of attention, emotion, and other functions (e.g., memory; Siegler, 1991). These and other functions located in the frontal lobe are responsible for selective attention (Miller, 1991), metacognition (Garner, 1991), and inhibitory control (Barkley, 1998). All of these functions are known to become more efficient with age and are associated with neurological maturation. In other words, the maturity hypothesis states that children born in the summer are cognitively less equipped to deal with the academic and social demands placed on them in a school setting.

The self-concept hypothesis is similar to the maturity hypothesis, except that it discusses the social obstacles encountered by the young-in-grade child. Martin et al. explain this hypothesis is derived from the fact that young-in-grade children at are a distinct social disadvantage when compared to their older, same-grade peers. Younger children tend to be physically smaller, weaker, and less physically and socially skilled. Taken cumulatively, these differences can result in lowered self-esteem, which leads to lower on-task behavior, and lower achievement when compared to older children (Pellegrini, 1992). This argument is commonly held by parents and education professionals. However, this hypothesis has been studied numerous times and has received little empirical support (Bickel, Zigmond, & Strayhorn, 1991; Spitzer, Cupp, & Park, 1995).

The gestational infection hypothesis refers to the notion that upper respiratory infections such as pneumonia and influenza occur with greater frequency during the winter months, peaking between December and the beginning of March (Glezen & Couch, 1997). These infections may impair CNS development if they occur during the second trimester of fetal development (Mednick et al., 1998; Takei et al., 1995). In their study of season-of-birth and dyslexia, Livingston et al. (1993) write that viral infection during the second trimester best explains the correlation they found with season-of-birth.

The last hypothesis frequently used to explain why children diagnosed with SLD and other affective problems are born disproportionately in the summer is the gestational vitamin D hypothesis. In annual models, the correlation between vitamin D and CNS development during the fetal period is viewed as supportive of risk to offspring of women, especially those being at higher latitudes (Eyles et al., 2003). These women receive less ultraviolet light during the winter and are more likely to be vitamin D deficient (Nesby-O'Dell et al., 2002), potentially marring the CNS development of their unborn child and the child's ability to function optimally in school.

The research on birth weight and season-of-birth support the gestational vitamin D hypothesis. Greater birth weight is considered a protective factor against pathology for newborn infants. Researchers in New Zealand conducted a study to test a hypothesis that is used to explain variations in birth weight. The hypothesis states that maternal exposure to increased sunlight during the first trimester of gestation is correlated with increased birth weight, length, and height when the child reaches 18 years old (Waldie et al., 2000). Tustin (2004) found that mothers who were exposed to bright sunshine during the first trimester had babies that were significantly heavier than those who did not receive the same sunshine. One can then hypothesize that these heavier children were less at risk for being born with or acquiring future pathology.

Other Hypothesis for Season-of-Birth

In their study which found that people with Panic Disorder (PD) were born with greater frequency than expected in the fall and early winter months, Castrogiovanni et al. (2002) state several possible explanations. First, they write that the mothers of children born in these months were more likely to have had a psychiatric disorder than those mothers who gave birth to children with panic disorder in the late winter, spring, and summer. They also cite the gestational infection hypothesis, noting that in the natural birth cycle more fertilization occurs in the winter; thus, more fetuses are vulnerable to influenza and other infections prominent in the winter. They also state that children born in the fall and early winter engage in less outdoor activity activities than babies born in milder seasons. Therefore, they assert that that these children are not able to engage in exploratory behavior and can become more behaviorally inhibited, a precursor to Panic Disorder (Rosenbaum JF, 1991). A neurological hypothesis states that people with PD seem to have more sensitive dopamine receptors and greater overall dopaminergic activity (Roy-Byrne et al., 1986; Gurguis et al., 1988; Pitchot et al., 1992). Season-of- birth and PD might be related to fluctuations of the dopaminergic system as was demonstrated both mice (Korytko, 1997) and humans (Partonen, 1996).

Goldberg et al. (2000) write that they are only able to speculate at this point about possible mechanisms for birth patterns and alcoholism. In addition to prenatal exposure to viral or other infections, they assert also that prenatal factors such as hormone secretions and changes in endocrine levels interact with genetic and environmental factors (such as viruses and infections) to effect phenotypic outcomes (Levine & Wojcik, 2002). Lastly, Goldberg et al. note that the birth pattern for male alcoholics and all illicit drug users followed the same pattern of increased fall births. They propose that the two share common etiological factors, noting that drug use and alcoholism are comorbid at about 45%.

De Messias et al. (2001) acknowledged the traditional hypothesis that mid-gestation infections and influenza, more common in the cold winter months, increased the risk of one being born with schizophrenia (SZ) in the late winter and spring. However, de Messias et al. argued that in many places, the temperature does not vary between the seasons; average rainfall does. De Messias et al. studied the number of SZ births in north-eastern Brazil, a place with a definite rainy season and relatively consistent temperature. De Messias et al. found that there was a “significant relationship” between rainfall and the number of SZ children born three months later, but no relationship between rainfall and births for the general population. They concluded that it was the prenatal influenza hastened by the rainy season that resulted in an increase in schizophrenic births three months later.

Perinatal Factors that May Predict Seasonal Effects

The purpose of this current study is to determine if certain perinatal events exhibit seasonal paths like those associated with seasonal pathology. If perinatal events are found to follow the same seasonal paths of certain pathologies, it would support the current biological hypotheses for the causes of seasonal patterns of pathology. Further, such an association would support the hypotheses that assert prenatal insults to the fetus (outwardly manifested as perinatal events) may be the cause of the pathologies that develop later in life.

The six perinatal events examined for seasonal patterns in this study are: Apgar score, birth weight, breech birth delivery, ventilation, fetal distress, and other complications of delivery. These six variables were chosen because after looking at birth records for the State of Georgia as provided by the National Center for Health Statistics (NCHS) under the auspices of the Center for Disease Control and Prevention of the Department of Health and Human Services, they were among the more frequently occurring perinatal complications. In other words, these six perinatal variables occurred often and consistently enough among Georgia births to account possibly for variations in seasonal patterns in psychopathology. In addition, these six variables have been associated with developmental problems of children.

Apgar Score

The Apgar test has been given to newborns for over 50 years to obtain measures of their immediate viability. In 1953, Virginia Apgar designed the Apgar test to yield a score that measured the total value of five clinical signs: heart rate, respiratory effort, reflex, muscle tone, and color (Moster, Lie, & Markestad, 2001). Each of these is rated on a 0-2 scale and summed for a total score, the maximum of which is 10. In general, scores between 7/8-10 are considered “good”; 3-7, “fair”; and 0-2, “poor” (Finster & Wood, 2005; Moster, Lie, Markestad, 2001). This study of

Apgar scores uses the following demarcations: 0-3 are "low"; 4-6 are "middle range"; and 7-10 are "high."

Virginia Apgar initially used her measure to predict infant mortality. She determined that infants who earned scores of 0-2 had a neonatal death rate of 14%; those scoring 3-7 had a death rate of 1.1%; those who scored 8-10 had a neonatal death rate of 0.13% (Finster & Wood, 2005). In addition to neonatal death, low Apgar scores have been shown to be associated with pathologies that develop later on in the newborn's life. For example, Nelson and Ellenberg (1981) recorded Apgar scores for 49,000 infants. These scores were recorded at one and five minute intervals and at 10, 15, and 20 minutes for babies who scores 7 or less at five minutes. The authors found mixed results for the predictive power of the Apgar score after following up with the children at 7 years. For example, low (0-2) scores were found to be a risk factor for cerebral palsy (CP). However, 55% of the children who developed CP had good scores (7-10) at one minute and 73% had good scores at five minutes. In addition, Nelson and Ellenberg found that of the 99 babies who had poor scores at 10, 15, and 20 minute intervals, 12 developed CP and 11 of these children were mentally retarded. In addition, 8 out of these low scoring children who did not develop CP did develop less severe disabilities later in life. However, Nelson and Ellenberg found that of the children who scored low at 10 minutes or later and survived, 80% did not have any type of significant pathology (Nelson & Ellenberg, 1981).

Researchers in Sweden conducted a study to look at three areas associated with Apgar scores. They wanted to a) find the prevalence of 5-minute Apgar scores below 7 (fair) born in their country between 1988-1997, b) determine what might cause fair-to-low Apgar scores and, c) find if there were any significant future risk-factors for infants receiving low scores at 5 minutes (Thorngren-Jerneck & Herbst, 2001). They found that from the 1,028,705 babies born during that time period, 7,787 (0.76%) received Apgar scores below 7 at five minutes. The researchers also found that the greatest risks for receiving an Apgar score below 7 at five minutes were vaginal breech deliveries and being the second born twin. In addition, primiparity (the number of children a woman has delivered), maternal age, smoking, male gender, and being born at night were also significantly related to Apgar scores below 7 at five minutes. Lastly, the study concluded that among the obstetric risk factors correlated with low five minute Apgar scores, death and severe neurological problems were the most significant.

A meta-analysis of publications from 1966-1997 that studied the association of newborn assessments to outcomes found that the Apagar test was not the best predictor for neonatal death (van de Riet, Vandenbussche, Le Cessie, & Keirse, 2002). However, when predicting cerebral palsy, the strongest associations were with the 20 minute Apgar scores in the poor range. It is important to note that this meta-analysis was interested only in finding the strongest *associations* between newborn assessments and either death or CP, and does not mean that the 20 minutes Apgar score is a strong *predictor* of CP.

Researchers in Chicago analyzed the outcomes of 93 stillborn newborns who received cardiopulmonary resuscitation (CPR) and who had Apgar scores of 0 or 1 at one minute of age (Ferre, Vidyasgar, Nath, & Sheftel, 1991). Short term analysis revealed that 62 of these children left the delivery room alive. However, 26 of these surviving 62 infants died in the neonatal period and 3 died during infancy. Of the 33 infants who survived, ten were lost and unavailable for further research. Regarding the long-term outcomes for these remaining 23 babies who survived stillbirth and extremely low Apgar scores, the researchers found that 14 developed normally, while 9 had experienced either “abnormal” or “suspect” development. The study also noted that of the original 93 newborns, 58 had Apgar scores of 0 at the ten minute assessment; 57 of these infants died (98%) and the lone survivor developed abnormally. These results seem to suggest that an Apgar score of 0 at the ten minutes mark is a strong predictor of newborn death or very poor developmental outcomes.

V.C. Toh (2001) conducted a study in an attempt to identify early predictors of major disabilities or death from factors available within the first two hours of a newborn’s life. Toh looked at 35 infants who had Apgar scores of 0-2, initial arterial pH of less than 7.20, and/or a 5 minute delay in respiration that required ventilation or resuscitation at birth. In addition, each of these infants was diagnosed with postasphyxial hypoxic-ischemic encephalopathy (HIE). Toh found a “severely adverse outcome” for 23 of the 35 newborns (66%), while 10 of the surviving infants had major neurologic sequelae. Toh determined that among other factors, a low 5 minute Apgar score was significantly associated with severely adverse outcomes. Toh noted further that the combination of a pH or 7.1 or less with a low Apgar score at 5 minutes resulted in a specificity and positive predictive power of 100%, although this result was less sensitive than other combinations of risk factors.

Krebs, Langhoff-Roos, and Thorngren-Jerneck (2001) analyzed the relationship between low Apgar scores in vaginal breech birth infants and the development of a “handicap” in these children once they began school. The results of a questionnaire given to mothers of 323 normally formed, singleton infants who were breech born at term found that 105 (33%) had Apgar scores of less than 7 at five minutes. Four of these children (5%) developed cerebral palsy while only one of the controls (Apgar score greater than 7) did. They found also that the infants with fair to low Apgar scores developed speech/language problems with greater frequency than control children. In addition, they found that 75% of the fair-low scoring Apgar group had no handicaps when they began school compared to 92% in the control group. However, they found that low scoring children were similar to controls in the areas of attention problems, motor control, perception, epilepsy, cognitive impairments, or learning problems. The authors determined that although low Apgar scores are indicative of an increased risk of neurological sequelae, fair to low Apgar scoring infants do not actually demonstrate to have significantly more disabilities later in childhood.

In summary, it appears that like any assessment, the Apgar test alone is not sufficient to make specific predictions about long-term outcomes. However, when aggregated with even one other measure, the Apgar becomes a useful tool to help identify risk of future pathology (Casey et al. 2001). It is important to remember the influence post-natal variables play in reducing the risk of pathology. Infant care, relationships with caregivers, and exposure to stimuli are just some additional important factors that help infants develop into normally developing school-age children.

Birth Weight and Gestation

Research suggests that birth weight and gestation length are strongly correlated. For example, approximately 11% (440,000) of children born each year in the United States are premature while approximately 9% (360,000) are low birth weight, very low birth weight, or extremely low birth weight (NCHS). It is likely that these percentages will increase in the coming years for several reasons. For example, rates of premature and low birth weight babies are increasing as a result of enhanced prenatal care. Thus, premature and low birth weight infants who would not have survived in the past are now surviving. In addition, there is an increased rate in the number of plural births due to use of fertility drugs and an increase in the number of older women giving birth; plural births and maternal age are associated with prematurity and low birth weight.

While there are several factors associated with prematurity and low birth weight, the greatest is ethnicity. Black Americans have four times more deliveries at less than 25 weeks gestation than white Americans, are three times more likely to have deliveries between 25-29 weeks of gestation and are two times more likely to have deliveries between 30-33 weeks of gestation. Bear in mind that normal gestation length is considered typically to be between 37-39 weeks. It is important to note that it does not appear that black mothers' increased risk for premature births is related exclusively to socio-economic status; African Americans have almost two times more low birth weight babies than any other minority (NCHS).

A second factor associated with prematurity and low birth weight is maternal age and whether or not the mother has given birth to twins, triplets, (plural births). For example, mothers less than 20 years old have more low birth weight babies than women who are at their peak reproductive ages. In addition, plural birth infants have significantly higher rates of prematurity and low birth weight than do singleton births (NCHS).

A third factor associated with prematurity and low birth weight is the presence of maternal disease. Research reveals that almost all maternal diseases, including anemia, diabetes, chronic hypertension, eclampsia, incompetent cervix, and uterine insufficiency, lead to increased risk for shorter pregnancy (NCHS).

There are several mechanisms that are used to explain prematurity and low birth weight. One such explanatory mechanism is that the mother experienced some form of intrauterine infection which results in the premature delivery and subsequent low birth weight of the child. Buchmayer et al. (2003) found that coccobacilli on Pap smears predicted preterm delivery at the odds ratio of 4.7. In other words, the mother was 4.7 time more likely to deliver prematurely if coccobacilli was present. In addition, Buchmayer et al. found coccobacilli and trichomonas vaginalis to be associated with small for gestational age babies. In their 2003 study, Simhan et al. analyzed birth data of almost 14,000 women and found that those with elevated levels of pH (>5.0) were associated with preterm delivery. Furthermore, they found that the presence of neutrophils in the mother's immune response was also associated with preterm pregnancy. Included in the infection hypothesis is the notion that the maternal infection can arise from sexual partners. For example, Vatten et al. (2003) found that mothers who changed sexual partners between births were at increased risk for preterm birth, low birth weight, and infant mortality.

In addition to the infection hypothesis as a causal mechanism for prematurity and low birth weight infants, several others are also being considered. Hasegawa et al. (2003) found that women who were classified as threatening preterm delivery had worse periodontal conditions than those who were not classified as such. They suggest that periodontal disease (subgingival plaque) may set up immune responses that trigger preterm births. In addition, Smith et al. (2003) found that women who had an interpregnancy interval of less than six months were more likely to have infants who experienced intrauterine growth restriction, preterm birth, and mortality. Lastly, Ross and Feldman (2000) found prematurity to be associated with high levels of respiratory distress syndrome (RDS), indicating that prematurity and low birth weight might be the result of poor prenatal oxygenation.

Low birth weight and preterm delivery are associated with long-term cognitive and behavioral effects on children. For example, Bhutta et al. (2002) found that low birth weight children demonstrated a mean difference of 10 IQ points compared to the general population. In other words, while the average IQ score for the general population is 100, the average score for low birth weight children is 90. The same authors conducted a meta-analysis of low birth weight studies and found that the majority demonstrated evidence of increased externalizing and internalizing behaviors. In addition, the majority of the studies found significantly more ADHD-like symptoms for low birth weight children than among controls.

When taking a closer look at the cognitive effects of low birth weight, Ross and Feldman (2000) found that at seven months, preterm, low birth weight infants performed more poorly on visual recognition memory tasks. They also found that at

12 months, these same children continued to perform more poorly on visual recognition memory tasks as well as tasks of tactual recognition memory and object permanence. At 11 years, children who were born preterm or low birth weight performed consistently less well on a variety of memory and perceptual measures. In addition, they found that at age 11, preterm and low birth weight children performed marginally lower on measures of receptive vocabulary and significantly lower on measure of fluency. To examine overall cognitive effects, the authors used a variety of cognitive measures given at 8 different points, (7 months, 1 year, 1.5 years, 2 years, 3 years, 4, years, 5 years, 6 years and 11 years), and found that children born preterm and low birth weight consistently scored 10 points lower than the general population.

To measure specific learning problems of preterm infants, Taylor et al. (1995) sought to determine if preterm and low birth weight infants developed learning disabilities over time even if their IQ was in the average range. Using the discrepancy model, they found that 40% of very low birth weight and low birth weight infants had learning disabilities in mathematics compared to just 4% of infants delivered at term. Carran et al. (1989) found that more preterm children were in mild mentally handicapped classrooms if they were from low SES environments. To measure the rate of attention problems Breslau et al. (1996) examined 739 low birth weight and preterm infants. When compared to controls, these infants displayed higher rates of attention problems than the controls, although there were negligible differences between samples on other variables.

To see if low birth weight and preterm infants were at greater risk for schizophrenia, Smith et al. (2001) examined birth histories of 270 adult schizophrenics. They found that the rate of low birth weight was high, associated with poorer premorbid functioning, and earlier schizophrenia onset. Specifically, the authors found that low birth weight was strongly associated with premorbid social withdrawal. This is helpful in this current study because several of the pathologies demonstrated previously to have seasonal effects (emotional behavioral disorder, autism, and ADHD) are associated with social withdrawal.

Breech Delivery

A breech birth occurs at the time of birth when the fetus presents with the buttocks, foot, or knee instead of the head or face. There are four types of breech births: complete, frank, footling, and knee. A complete breech is when the fetus' thighs are flexed upon its abdomen and its legs are then flexed upon its thighs. A frank breech describes when both of the fetus' entire legs are extended over the ventral body surface. A footling breech occurs when the foot presents to the cervical opening; a knee breech is when the knee presents (NCHS).

In their 2002 study, Roberts et al. found that low birth weight and Apgar scores were associated with breech birth at term. Mekbib (1995) found that of 291 vaginal breech deliveries in a hospital in Ethiopia, 28% were born at less than 2,500 grams and 57% had one-minute Apgar scores less than 7. In addition, 91% of these births occurred at less than 28 weeks gestation. When compared to the mortality rate for normal deliveries (70 per 1,000), breech deliveries resulted in a substantially greater mortality rate of 330 per 1,000.

Taylor and Francis (2001) examined several neonatal variables and compared them across samples of breeched infants who were either delivered vaginally or through cesarean section. The authors found that infants in breech presentation who were vaginally delivered had greater rates of low Apgar scores and referral to neonatal intensive care units. In addition, the rate of neurological morbidity was significantly higher in vaginally delivered breeched infants. In a similar study, Roman et al. (1998) found that vaginally delivered breech infants were at a greater risk of infant mortality and birth injury than those delivered through cesarean section. The authors also found that all breech presenting infants were at increased risk of receiving Apgar scores of 5 or lower. In addition, Thorpe-Beeston et al. (1992) found that the risk for low Apgar scores and neonatal intubation were doubled in breeched infants who were either delivered vaginally or through emergency cesarean section.

Ventilation

Neonates who require ventilation at birth are very often low birth weight and premature. Therefore, there exists little research that studies that study the long-term effects of neonatal ventilation without taking these other variables into account. However, some researchers have attempted to isolate long-term outcomes from neonatal ventilation. For example, Andreasson et al. (1989) conducted follow-up lung examinations of 8-10 year old children who were ventilated as neonates. They found that ventilated neonates exhibited significant respiratory problems as children and recommended further follow-up studies. Riedel (1987) conducted a five year follow-up assessment of children who had received artificial ventilation of neonates. Riedel found that 19% of these children had developed bronchopulmonary dysplasia, 26% had more than 10 upper respiratory infections per year, and 33% had developed recurrent obstructive airway disease. Riedel also found that the degree of bronchial hyperreactivity was significantly correlated with the duration of neonatal ventilation.

Fenton, Mason, Clarke, and Field (1996) found that increased neonatal care, including ventilation, improved infant survival rates among their sample. However, they found that the amount of respiratory care, birth weight, and gestation length were correlated with increased levels of lung disease. Carlo et al. (2002) compared outcomes for children who received minimal ventilation at birth with those who received routine ventilation. They found that minimal ventilation did not reduce the incidence of either death or bronchopulmonary dysplasia among the children in their study.

It is important to mention that none of the outcomes described are specifically related to learning or school-based education. However, it stands to reason that a school-age child who suffers from bronchopulmonary dysplasia or chronic upper respiratory infections as a result of receiving ventilation as a neonate is likely to be distracted by breathing problems, miss more school for doctor and hospital visits, and have more adverse schooling outcomes overall than peers who did not receive ventilation as neonates.

Fetal Distress

Fetal distress is the term used to describe any situation in which the fetus may be in jeopardy as a result of increased heart rate due to not receiving enough oxygen. This can be the result of several factors including maternal anemia, heart disease, low blood pressure, an improperly functioning placenta, problems with the umbilical cord, fetal infection, and prolonged labor contractions (Stone & Eddleman, 2003).

Dellinger et al. (2000) sought to determine the relationship fetal distress had on three neonatal variables: 1 minute Apgar scores, 5 minute Apgar scores, and admission to a neonatal intensive care unit. The authors examined neonatal records from 898 children and grouped them into three categories: those who had normal heart rates at delivery, those who experienced fetal stress, and those who experienced fetal distress. Dellinger et al. found that there was a significant worsening of performance on the three variables. For example, while 5.1% of normal children received depressed 1 minute Apgar scores, 18.3% and 75% of the stressed and distressed infants received comparable scores. Similarly, while 1.0% of normal children received less than "good" 5 minute Apgar scores, 3.8% of stressed infants and 37.5% of distressed infants received depressed scores. Lastly, while 5.6% of normal heart rate infants were required to enter a neonatal intensive care unit, the percentages for stressed and distressed heart rate infants was considerably higher (10.6% and 37.5% respectively). Dellinger et al.'s study clearly demonstrates a relationship between fetal distress and lower one minute Apgar scores, 5 minute Apgar scores, and admittance to neonatal intensive care units.

Summary

Prior research has demonstrated that children with pathologies such as specific learning disability (SLD), speech-language impairment (SLI), anxiety, and dyslexia are born at significantly greater and disproportional rates during the summer months, specifically June, July, and August. In addition, a large body of research indicates that children born with psychiatric/medically derived pathologies such as autism, and severe mental impairment are born at significantly greater and disproportional rates during the late winter months of February, and March. The purpose of this study is to examine data from 6 perinatal events gathered between 1991-2002 and determine if there are any meaningful monthly variations in birth patterns. If this is the case, this study will determine if the anomaly birth rate peak and nadir periods are the same for white and black infants. Last, this study will determine if the monthly variations occur in significant cycles. It is hoped that this study will find that causal mechanisms of pathologies can be, in part, attributed to prenatal events which are manifested as negative perinatal outcomes.

CHAPTER 3

METHOD

Sample

All natality data and associated variables were obtained from the Natality Data Sets issued by the National Center for Health Statistics (NCHS) under the auspices of the Center for Disease Control and Prevention of the Department of Health and Human Services. All data in the Natality Data Set were gathered from U.S. Standard Certificates of births occurring to United States residents and non-residents inside the United States as issued by the Public Health Service. Although each State modifies their birth certificates slightly, the NCHS determined that most State birth certificates conform closely enough in content to the standard birth certificate to obtain uniformity of the content of the data collected.

This study analyzed live birth data for the State of Georgia for the years 1991-2002. Approximately 99% of all births that occurred in the United States during this time period are accounted for in this data set. As defined by the World Health Organization, a live birth is the product of conception, regardless of the length of pregnancy, that displays any sign of life such as breathing, heart beating, pulsation of the umbilical cord, or voluntary muscle movement. Both the United Nations and the NCHS have adopted this definition of live birth. Natality data from Georgia was used because the studies to which they are compared used only children in Georgia public schools.

This study analyzed data only from live births occurring to White non-Hispanics and African American non-Hispanics who displayed the following variables: breech delivery, fetal distress, other complications of labor and/or delivery, and ventilation before and after 30 minutes of delivery. In addition, infant birth weight, and five minute Apgar scores were analyzed. These variables were chosen because they have been associated with developmental problems of children. The following definitions are provided by the CDC and accompany the data set for each variable chosen.

A breech birth occurs at the time of birth when the fetus presents with the buttocks or foot, instead of the head or face. There are four types of breech births: complete, frank, footling, and knee. A complete breech is when the fetus' thighs are flexed upon its abdomen and its legs are then flexed upon its thighs. A frank breech describes when both the fetus' entire legs are extended over the ventral body surface. A footling breech occurs when the foot presents to the cervical opening; a knee breech is when the knee presents.

Fetal distress is the term describing any situation in which the fetus may be in jeopardy as a result of not receiving enough oxygen (Stone & Eddleman 2003). This can be the result of several factors including maternal anemia, heart disease, low blood pressure, an improperly functioning placenta, problems with the umbilical cord, fetal infection, and prolonged labor contractions (Stone & Eddleman 2003).

The variable "other complications of labor and/or delivery" refers to complications not denoted on a checklist of 15 specific complications from which the attending physician may select during labor or delivery. A large proportion of birth complications are described as "other." A choice of "None" is provided as well. If the checklist is not completed at all, it is classified as "not stated."

Infant ventilation refers to a mechanical method of assisting respiration. This study analyzed if ventilation occurred for a period less then 30 minutes after delivery and at 30 minutes or longer following delivery.

Infant birth weight was also analyzed in this study. Although birth weight is sometimes reported in pounds and ounces, this study uses the metric system. The following is a Table which converts gram intervals to their equivalents in pounds and ounces:

Less than 500 grams = 1lb 1oz or less
500-999 grams = 1 lb 2oz – 3lb 3oz
1,000-1,499 grams = 2lb 4oz – 3lb 4oz
1,500-1,999 grams = 3lb 5oz – 4lb 6oz
2,000-2,499 grams = 4 lb 7oz – 5lb 8oz
2,500-2,999 grams = 5 lb 9oz – 6 lb 9oz
3,000-3,499 grams = 6 lb 10 oz – 7 lb 11oz
3,500-3,999 grams = 7 lb 12 oz – 8lb 13 oz
4,000-4,499 grams = 8 lb 14oz – 9lb 14 oz
4,500-4,999 grams = 9 lb 15 oz – 11 lb 0oz
5,000 grams or more = 11 lb 1 oz or greater

For the purposes of this study, the following infant birth weight categories were studied: less than 1,000 grams; 1,000-1,499 grams; 1,500-1,999 grams; and 2,000-2,499 grams.

The Apgar score is used to determine infant viability at certain points following delivery. It is the summary measure of the total value of five clinical signs: heart rate, respiratory effort, reflex, muscle tone, and color. Each of these is rated on a 0-2 scale and summed for a total score, the maximum of which is 10. Scores between 7/8-10 are considered "good"; 3-7, "fair"; and 0-2, "poor" (Finster & Wood, 2005;

Moster, Lie, Markestad, 2001). For this study, data from 5 minutes Apgar scores were analyzed and demarcations of “low” (0-3), “middle” (4-6), and “high” (7-10) were used.

Data Analytic Procedures

This study will include analyzed descriptive statistics for every variable. In cases of perinatal anomalies, these descriptive statistics will include: number of births in Georgia per month, frequencies of anomalous births per month, the rate of anomalous births per month (number of anomalous births/birth total), and adjusted rate of anomalous births per month from 1991-2002 (total yearly mean rate of anomalous births - rate of anomalous births per month). Figures and Tables reflect the adjusted rate of anomalous births unless otherwise specified.

The three specific questions stated in the purpose will be addressed. Question one asked if there are meaningful monthly variations in birth rates for any of the perinatal anomalies. To test for this, a demarcation of 8% difference from the total monthly mean of that particular anomaly will be used. Question two asked if white and black infants had similar meaningful variations of monthly birth rates. To determine this, analyses of white and black rates of anomalies and birth patterns will be conducted and examined separately prior to comparison. The third question asked if there were significant birth rate cycles for the anomalies. To test for this, a spectral analysis of the time series of the rates of anomalies will be conducted.

CHAPTER 4

RESULTS

Tables 1-6 and Description

Tables 1-6 present the frequency of white and black births per year for each perinatal anomaly for the years 1991-2002. The data for 5 minute Apgar scores are not complete for these years because the data were not recorded prior to 1995.

These six perinatal anomalies were selected because they were high frequency anomalies. High frequency anomalies were desired because this study divided each anomaly into monthly birth frequencies, making a large enough sample size imperative. Tables 1-6 demonstrate that the number of incidents per anomaly for white and black infants occurred in sufficient enough numbers to analyze. For a complete descriptive analysis of each perinatal anomaly, see Appendix A.

Table 2 (Number of GA Infants that Required Ventilation at 30 Minutes or Less and at More Than 30 Minutes after Delivery: 1991-2002) elicited some concern in that the frequency of births between 1993-1997 clearly are much larger when compared to the frequencies of other years in the Table. The cause for this increased frequency is not altogether known, although it may be the result of a change in hospital procedure regarding ventilation in Georgia for those years. However, these data were analyzed in the same fashion as all other data in this study.

Table 1

Number of GA Breech Births: 1991-2002

Year of Birth	White	Black
1991	2,455	1,064
1992	2,417	1,136
1993	2,407	1,095
1994	2,318	1,041
1995	2,341	901
1996	2,460	837
1997	2,347	891
1998	2,526	1,042
1999	2,401	1,052
2000	2656	1,073
2001	2685	1,121
2002	2692	1,169
Total	29,705	12,422

Table 2

Number of GA Infants that Required Ventilation at 30 Minutes or Less and at More Than 30 Minutes after Delivery: 1991-2002

	Less Than 30 Minutes		More Than 30 Minutes	
Year of Birth	White	Black	White	Black
1991	546	434	417	509
1992	801	724	424	493
1993	1,628	1,774	438	427
1994	2,202	2,186	435	381
1995	1,734	1,807	519	407
1996	1,556	1,670	597	438
1997	1,199	1,070	536	353
1998	531	271	546	265
1999	491	258	544	280
2000	608	287	570	304
2001	719	317	667	344
2002	782	381	701	380
Total	12,797	11,179	6,394	4,581

Table 3

Number of GA Infants that Experienced Fetal Distress at Delivery: 1991-2002

Year of Birth	White	Black
1991	2,511	1,743
1992	2,232	1,706
1993	2,297	1,869
1994	2,357	1,708
1995	2,187	1,524
1996	2,640	1,660
1997	2,223	1,589
1998	1,849	1,594
1999	1,804	1,472
2000	1,612	1,309
2001	1,610	1,220
2002	1,699	1,368
Total	25,021	18,762

Table 4

Number of GA Infants Receiving 5 Minute Apgar Scores of 0-3, 4-6, and 7-10: 1995-2002

Year of Birth	0-3		4-6		7-10	
	W[1]	B[2]	W	B	W	B
1995	186	335	489	583	65585	37135
1996	223	351	532	544	65326	37068
1997	216	321	489	592	66889	38259
1998	204	311	496	692	68502	39716
1999	176	294	477	611	69041	40357
2000	198	355	518	636	69546	42192
2001	216	355	517	610	68304	41922
2002	213	339	518	606	67260	40880
Total	1632	2661	4036	4874	540453	317559

[1]W = white infants; [2]B = black infants

Table 5

Number of GA Infants Who Weighed Less than 1,500g (Very Low Birth Weight); 1,500 – 2,499g (Low Birth Weight); Greater than 2,500g (Normal-High Birth Weight) at Delivery: 1991-2002

Year	Less than 1,500g		1,500-2,499g		Greater than 2,500g	
	W[1]	B[2]	W	B	W	B
1991	662	1149	3359	4002	61468	34990
1992	642	1144	3283	4106	61851	35003
1993	723	1196	3386	3783	61157	34499
1994	709	1137	3437	3838	61152	33852
1995	681	1168	3680	3829	62128	33211
1996	725	1094	3584	3759	62028	33303
1997	809	1202	3732	3930	63325	34264
1998	801	1235	3762	3980	64925	35687
2002	784	1201	3993	4098	65234	36219
2000	829	1336	3919	4219	65761	37802
2001	828	1252	4023	4303	64440	37496
2002	781	1238	4018	4326	63461	36413
Total	8974	14352	44176	48173	756930	422739

[1]W = white infants; [2]B = black infants

Table 6

Number of GA Infants that Experienced Other Complications of Labor/Delivery: 1991-2002

Year of Birth	White	Black
1991	7,337	4,478
1992	7,076	4,556
1993	7,627	4,594
1994	7,118	4,580
1995	7,748	5,108
1996	8,295	5,426
1997	8,714	5,655
1998	8,954	5,827
1999	9,436	5,865
2000	10,700	6,711
2001	12,458	7,031
2002	12,724	7,305
Total	108,187	67,136

Hypothesis Results

Apgar Scores

The initial question posed in this study focused on the differential birth patterns of the Apgar scores assigned to children at 5-minutes after birth. It was hypothesized that for white and black children, those assigned the less than optimal low (0-3) and middle (4-6) Apgar scores would be born at a meaningfully greater rate in the late winter or summer months. Data relevant to this hypothesis are presented in Tables 7 and 8.

An inspection of the mean birth rates of white children with low Apgar scores revealed a birth peak in February a rate that was 20% greater than the mean and a March nadir that was 14% less than the mean. A smaller peak for white low Apgar scores was found in October that was 13% greater than the mean while a smaller nadir was found in January that was 10% less (Table 7; figure 1). In addition, the mean rates of white children assigned middle Apgar scores peak at 8% greater than the mean in May and June, with a nadir in February (Table 7; figure 2). Birth rates of white children with high Apgar scores did not indicate any variations greater than 8% from the total mean number of births. Spectral analysis was then conducted to determine if the mean birth rates of white children with each grouping of Apgar scores (low, middle, high) took place in regularly occurring cycles of 1 year, 6 months, 4 months, or 3 months at significant levels. Analysis revealed that white children with low and high Apgar scores did not have significant cycles of birth. However, spectral analysis revealed that white children with mid-range Apgar scores demonstrated a significant six month cycle (9.7% of variance explained $p<.05$).

Table 7

Apgar Scores: White Rate for Infants

	0-3		4-6		7-10	
	Rate	SD	Rate	SD	Rate	SD
Jan.	.26%	.06	.72%	.08	98.62%	.14
Feb.	.35*	.07	.68	.09	98.54	.10
Mar.	.25	.08	.77	.08	98.60	.13
Apr.	.31	.04	.80	.16	98.52	.18
May	.29	.07	.81*	.09	98.47	.12
Jun.	.27	.05	.81*	.11	98.50	.16
Jul.	.30	.03	.72	.11	98.79	.45
Aug.	.26	.07	.72	.11	98.69	.13
Sep.	.30	.06	.70	.10	98.66	.15
Oct.	.33*	.05	.73	.11	98.60	.14
Nov.	.28	.03	.77	.12	98.57	.12
Dec.	.29	.08	.72	.07	98.60	.15
Average	.29	.06	.75	.11	98.59	.19

Rate equals the number of births with these Apgar Scores divided by the total number of births; * = monthly rates that are greater than 8% than the total average rate.

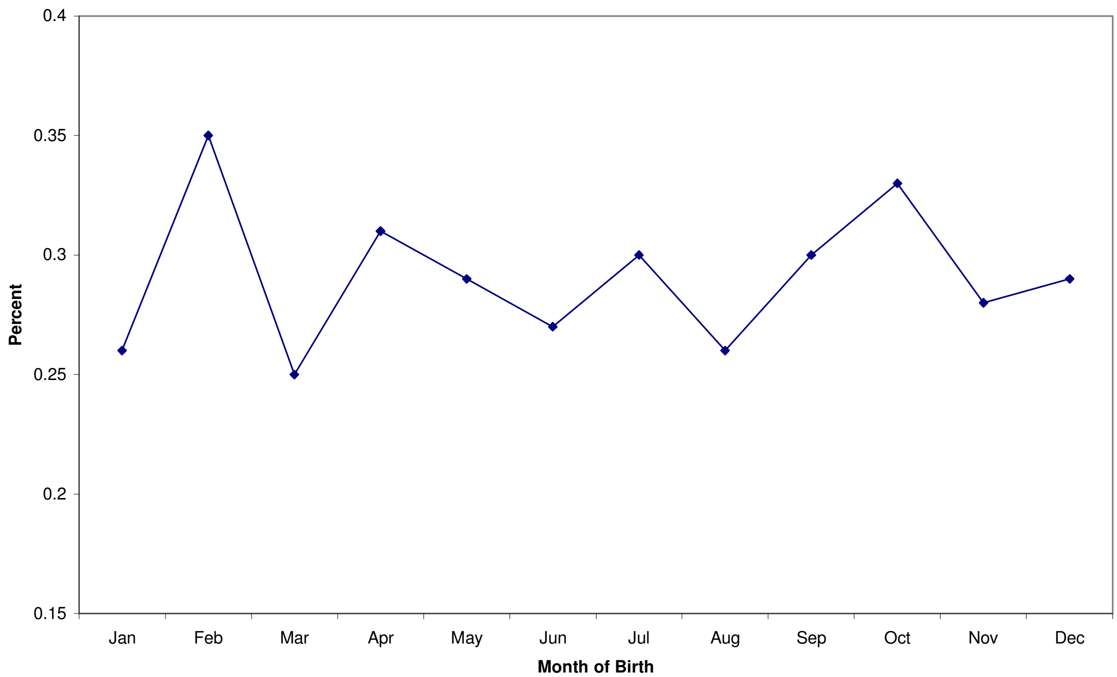

Figure 1

Mean Percent of White GA Births with Apgar Scores 0-3: 1995-2002

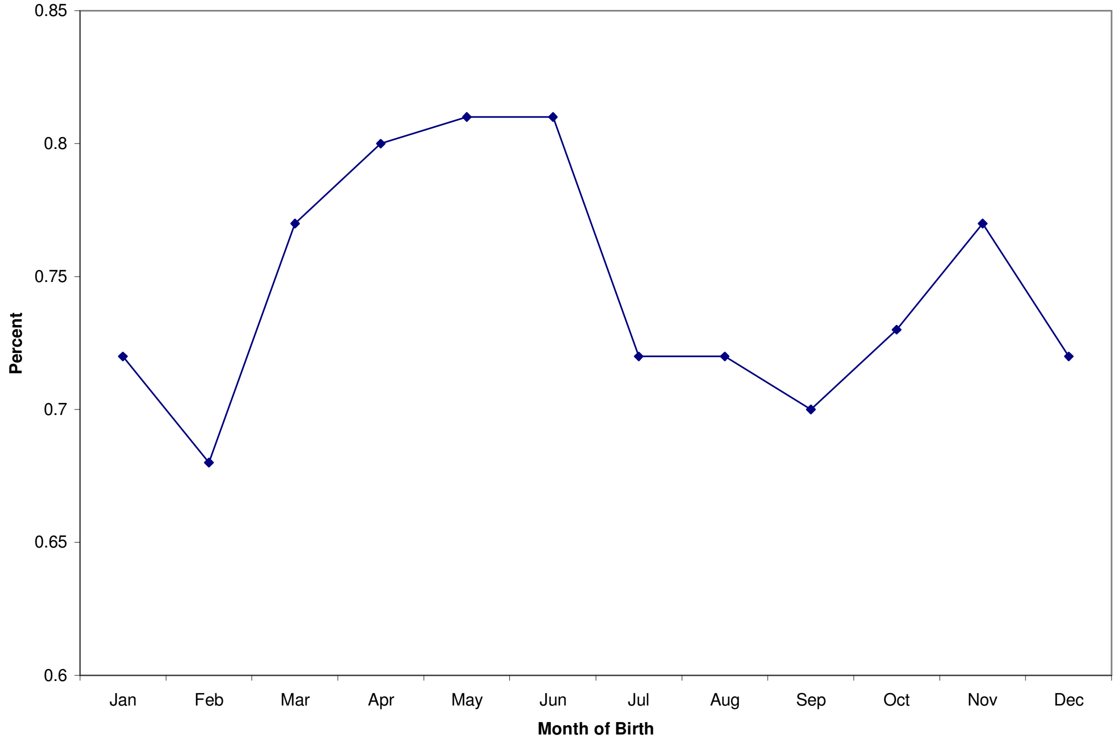

Figure 2

Mean Percent of White GA Births with Apgar Scores 4-6: 1995-2002

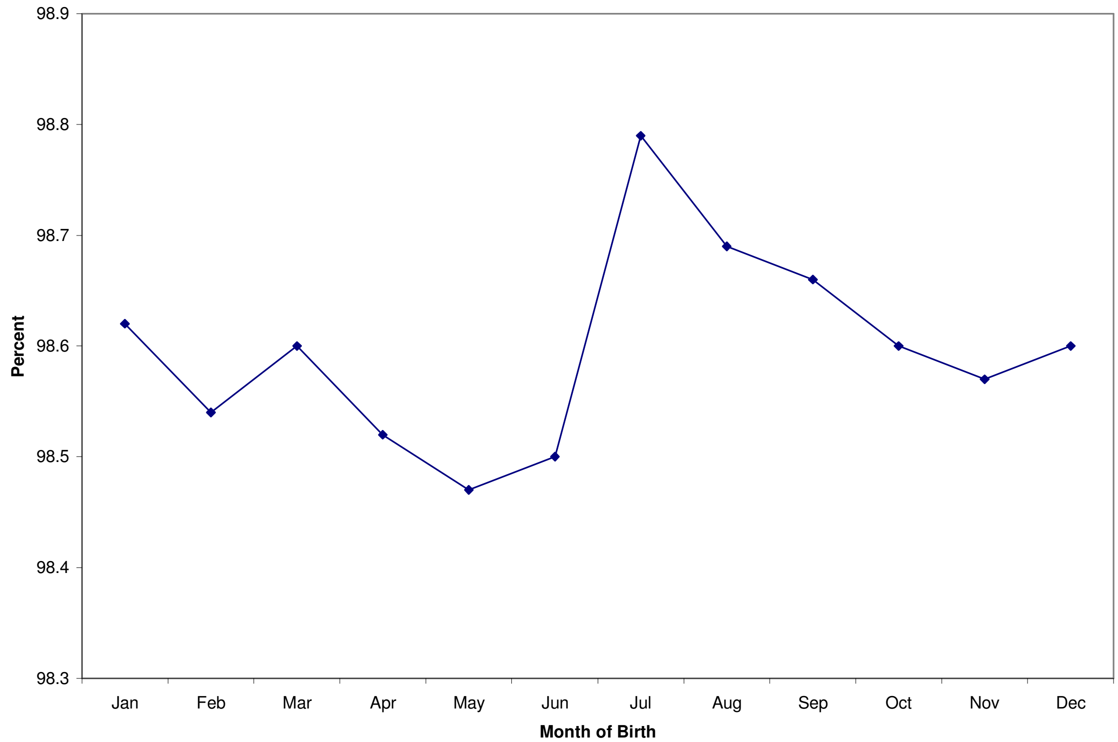

Figure 3

Mean Percent of White GA Births with Apgar Scores 7-10: 1995-2002

Table 8

Apgar Scores: Black Rate for Infants

	0-3		4-6		7-10	
	Rate	SD	Rate	SD	Rate	SD
Jan.	.74%	.14	1.40%	.13	97.26%	.41
Feb.	.90*	.08	1.33	.20	96.85	1.12
Mar.	.76	.15	1.47	.14	97.23	.39
Apr.	.92*	.19	1.40	.21	97.19	.57
May	.95*	.23	1.45	.26	97.09	.62
Jun.	.87	.12	1.57	.28	97.09	.40
Jul.	.78	.07	1.59*	.18	97.19	.28
Aug.	.81	.11	1.56	.17	97.16	.28
Sep.	.76	.14	1.46	.20	97.28	.47
Oct.	.83	.13	1.47	.19	97.17	.44
Nov.	.76	.11	1.42	.24	97.42	.67
Dec.	.75	.18	1.46	.15	97.79	.29
Average	.82	.15	1.46	.20	97.23	.53

Rate equals the number of births with these Apgar scores divides by the total number of births; * = monthly rates that are greater than 8% than the total average rate. Note: rows do not sum to 100 due to minor errors introduced by the annual adjustment procedure used. Error did not alter monthly variation

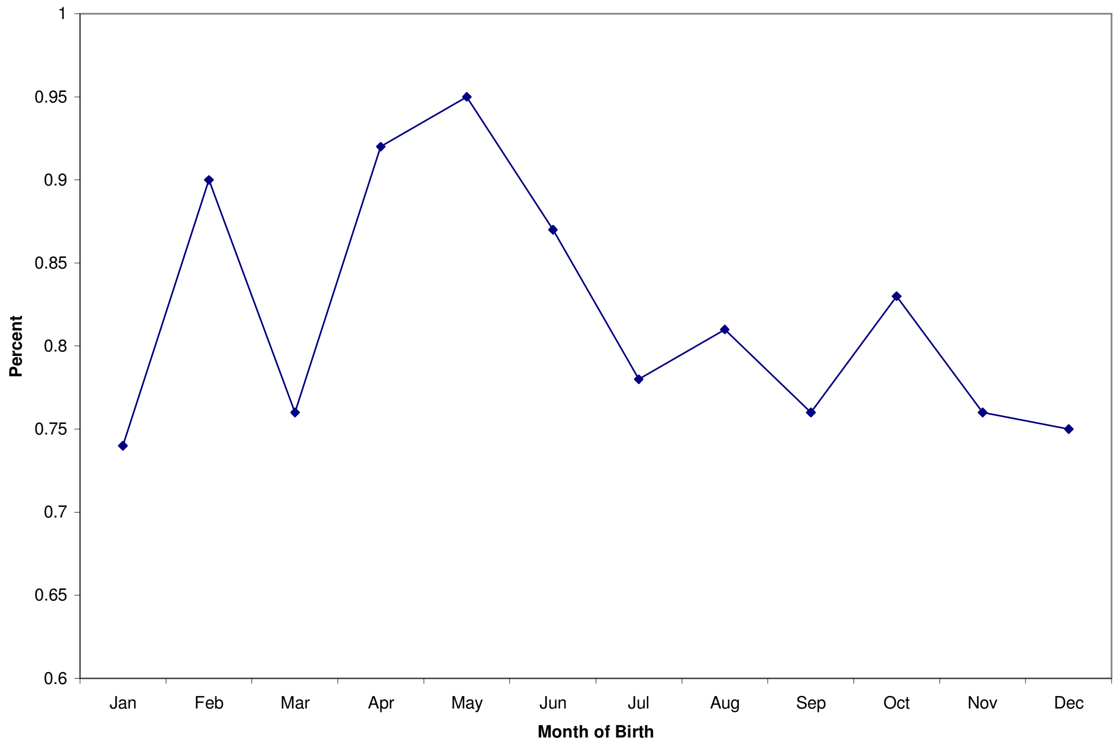

Figure 4

Mean Percent of Black GA Births with Apgar Scores 0-3: 1995-2002

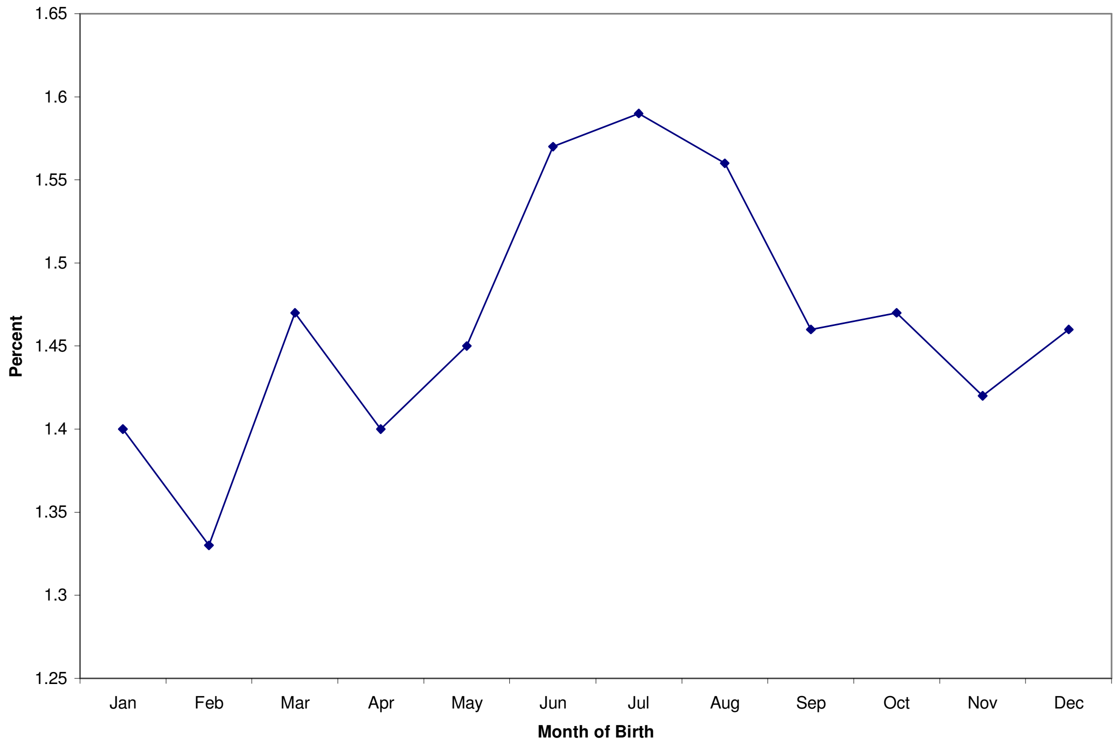

Figure 5

Mean Percent of Black GA Births with Apgar Scores 4-6: 1995-2002

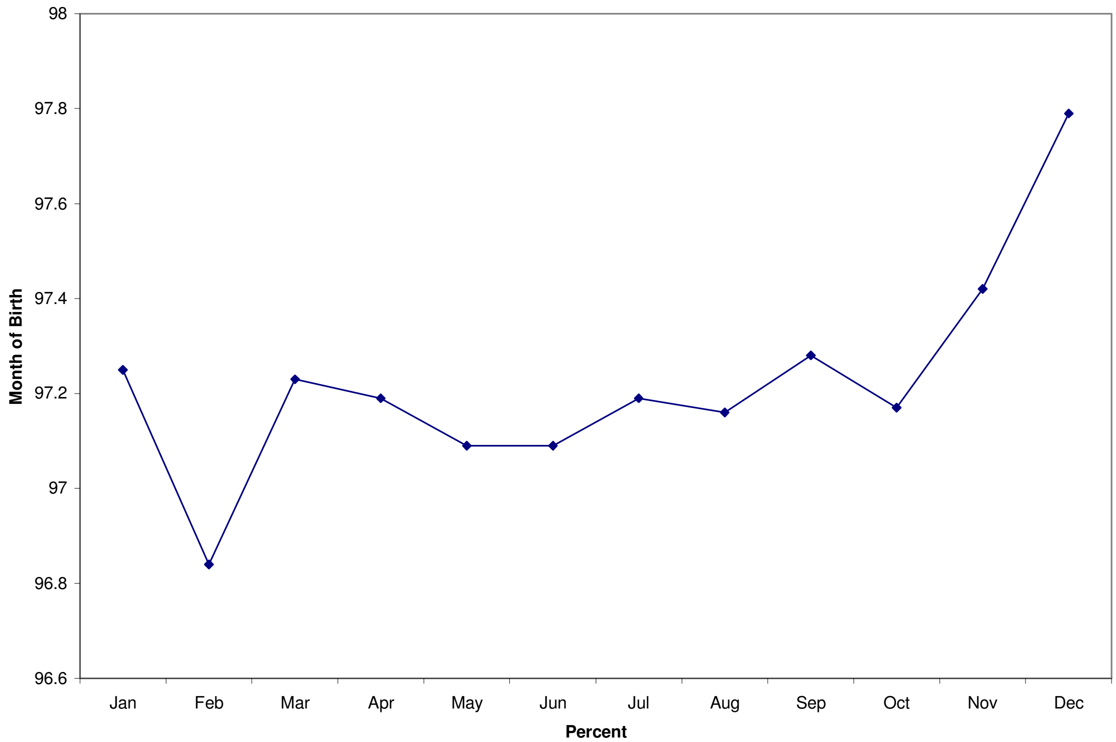

Figure 6

Mean Percent of Black GA Births with Apgar Scores 7-10: 1995-2002

An inspection of the mean birth rates of black children with high Apgar scores (Table 8) did not indicate any birth peaks (Table 8; figure 6). However, black children born with low Apgar scores showed a birth rate peaking in the months of April (12% greater than the mean) and May (16% greater than the mean). In addition a smaller peak was demonstrated in February (9% greater than the mean) while a meaningful nadir was found in December (9% less than the mean) and January (10% less than the mean). Black children with middle Apgar scores demonstrated a birth rate peak in July that was 9% above the mean and a nadir in February that was also 9% below the mean (Table 8; figures 5). As with the white children, spectral analysis was conducted to determine if the mean birth rates of black children with each grouping of Apgar scores (low, middle, high) took place in regularly occurring cycles of 1 year, 6 months, 4 months, or 3 months at a significant level. Spectral analysis revealed that births of black children in none of the Apgar score groupings revealed significant cycles. However, it is important to note that the mean rate of births of black children with Apgar scores in the middle range in the month of July (1.59) was over one standard deviation greater than the rate that occurred in February (1.33).

Birth Weight

It was hypothesized that for white and black children, those born at very low birth weight (less than 1500g) and low birth weight (1500-2499g) would be born with greater than expected frequency in the late winter and summer months. Data relevant to this hypothesis are presented in Tables 9 and 10, and graphically represented in figures 7 through 9.

An inspection of the mean birth rates of white children born at very low birth weight revealed a peak in June that was 8% greater than the mean of all white births at that weight (Table 9; figure 7). An inspection of the mean birth weights of white children born at low birth weight (1500-2499g) did not reveal a meaningful birth peak (Table 9; figure 8). Mean rates of white children with normal-high birth weights also did not reveal any birth peaks that were greater than 8% of the mean. Spectral analysis was conducted to determine if the mean birth rates of white children with very low, low, and normal-high birth weights took place in regularly occurring cycles of 1 year, 6 months, 4 months, or 3 months at significant levels. This analysis revealed that none of the three groups had births patterns that fit any of the cycles studied.

An inspection of the mean birth rates of black children born at very low birth weight reveals meaningful births peak in the consecutive months of May (9% greater than the total mean number of black infants born at that birth weight) and June (13% greater; Table 10; figure 10). This same analysis found a meaningful nadir in February that was 10% below the mean. An inspection of the mean birth weights of black children born at low birth weight did not reveal any meaningful birth peaks (see figure 11). In addition, normal-high birth weights did not demonstrate having any birth peaks that were greater than 8% above the mean. Spectral analysis was then conducted to determine if the mean birth rates of black children with very low, low, and normal-high birth weights took place in regularly occurring cycles of 1 year, 6 months, 4 months, or 3 months at significant levels. These analyses revealed that black children with very low birth weight (less than 1500g) had a significant 12-month cycle (14.11% of variance explained, $p<.05$).

Regarding black low birth weight infants (1500-2499g), the spectral analysis was not significant. However, regarding normal-high birth weight black infants, spectral analysis revealed that the overall birth pattern from 1991-2002 occurred at a significantly annual cycle (13.23% of variance explained, $p<.05$).

Fetal Distress

It was hypothesized that for white and black children, those born experiencing fetal distress at delivery would be born with greater than expected frequency in the late winter and summer months. Data relevant to this hypothesis are presented in Tables 11 and figures 13 and 14.

An inspection of the mean birth rates of white children born experiencing fetal distress at delivery did not reveal a birth peak greater than 8% of the total mean rate. Spectral analysis was then conducted to determine if the mean birth rates of white children experiencing fetal distress at delivery took place in regularly occurring cycles of 1 year, 6 months, 4 months, or 3 months at significant levels. This analysis revealed no significant cycles.

Similarly, an inspection of the mean birth rates of black children experiencing fetal distress at delivery did not reveal a birth peak greater than 8% of the total mean rate. Spectral analysis however indicated there were no significant cyclical patterns.

Table 9

Birth Weights: White Rate for Infants

	Less than 1500g		1500-2499g		Greater than 2500g	
	Rate	SD	Rate	SD	Rate	SD
Jan.	1.16%	.16	5.43%	.36	93.38%	.42
Feb.	1.08	.15	5.32	.37	93.56	.43
Mar.	1.05	.20	5.31	.29	93.61	.46
Apr.	1.10	.18	5.30	.33	93.57	.36
May	1.17	.14	5.31	.23	93.49	.34
Jun.	1.20*	.20	5.43	.39	93.34	.54
Jul.	1.08	.10	5.79	.92	93.10	.88
Aug.	1.02	.14	5.35	.29	93.60	.34
Sep.	1.11	.23	5.34	.39	93.53	.46
Oct.	1.08	.14	5.53	.30	93.69	1.08
Nov.	1.12	.20	5.38	.42	93.46	.40
Dec.	1.15	.21	5.69	.44	93.13	.53
Average	1.11	.18	5.43	.44	93.45	.57

Rate equals the number of births at this weight divided by the total number of births;

* = monthly rates that are greater than 8% than the total average rate.

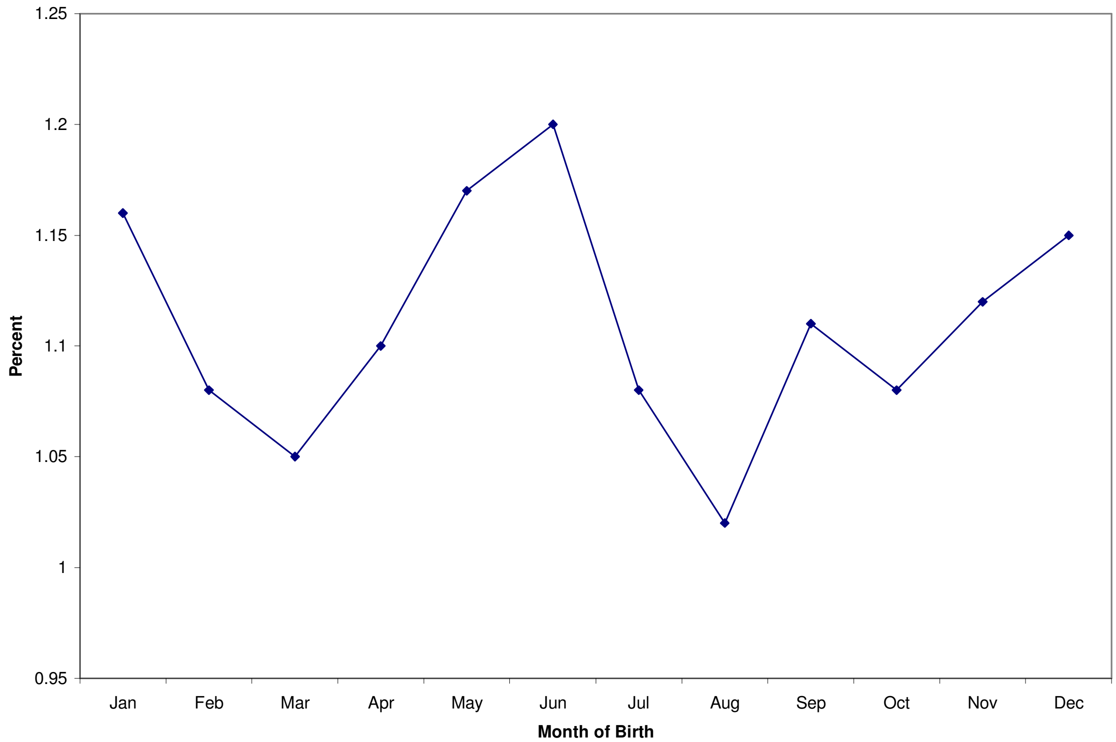

Figure 7

Mean Percent of White GA Births Weighing Less Than 1500g (Very Low Birth Weight): 1991-2002

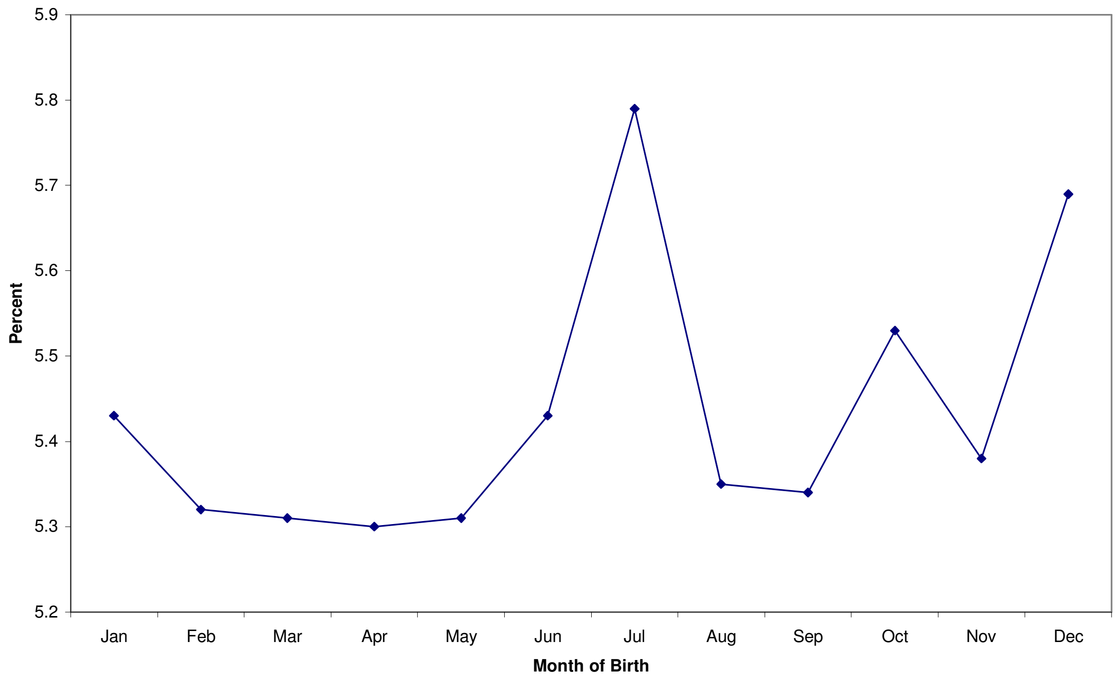

Figure 8

Mean Percent of White GA Births Weighing 1500-2499g (Low Birth Weight): 1991-2002

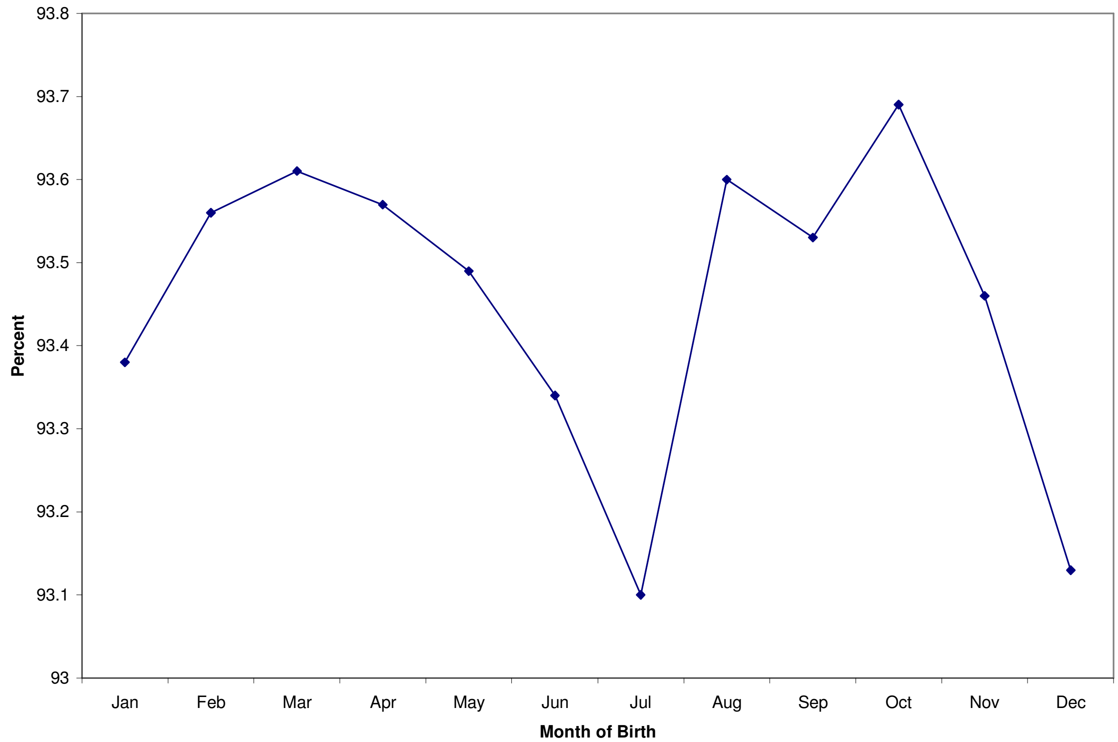

Figure 9

Mean Percent of White GA Births Weighing More Than 2500g (Normal-High Birth Weight): 1991-2002

Table 10

Birth Weights: Black Rate for Infants

	Less than 1500g		1500-2499g		Greater than 2500g	
	Rate	SD	Rate	SD	Rate	SD
Jan.	2.82%	.32	9.90%	.61	87.30%	.71
Feb.	2.66	.34	9.65	.37	87.72	.54
Mar.	2.78	.38	9.60	.73	87.66	.78
Apr.	3.08	.18	9.80	.46	87.14	.46
May	3.24*	.36	9.88	.54	86.91	.67
Jun.	3.34*	.37	10.29	.63	86.40	.78
Jul.	2.97	.34	10.42	.61	86.65	.69
Aug.	2.94	.09	9.90	.46	87.19	.49
Sep.	2.91	.27	9.85	.51	87.28	.44
Oct.	3.10	.22	10.48	.66	86.46	.61
Nov.	2.85	.28	9.80	.44	87.29	.61
Dec.	2.85	.34	9.94	.53	87.23	.73
Average	2.96	.35	9.96	.60	87.10	.73

Rate equals the number of births at this weight divided by the total number of births;

* = monthly rates that are greater than 8% than the total average rate.

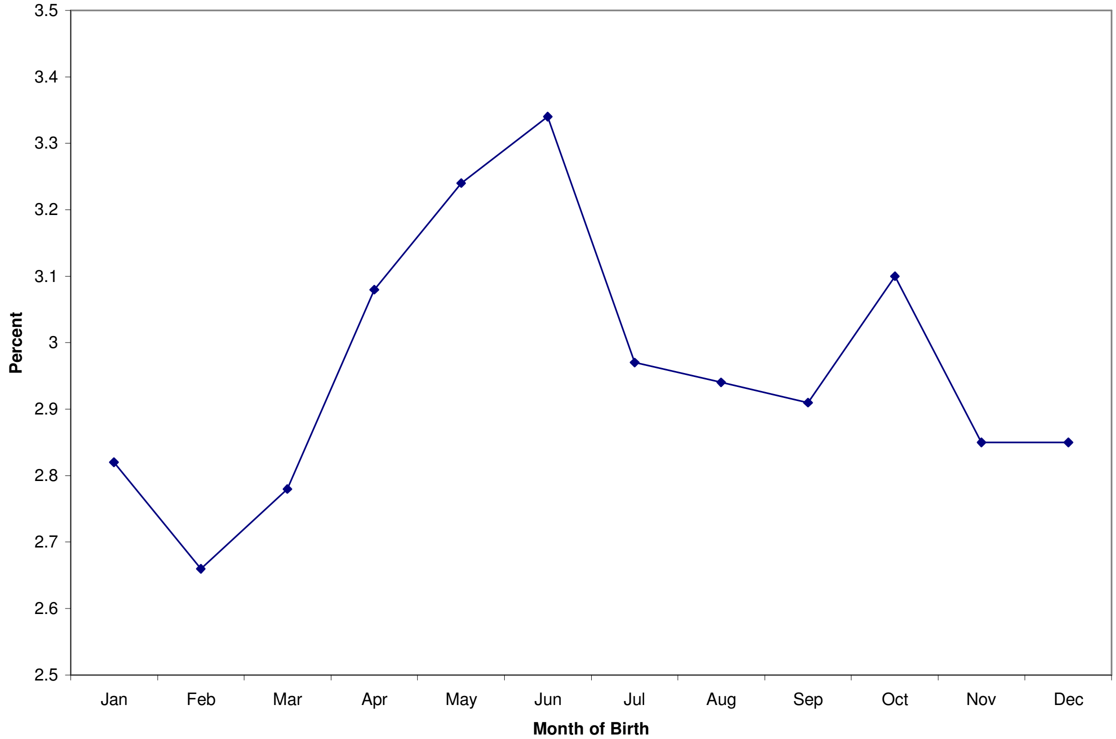

Figure 10

Mean Percent of Black GA Births Weighing Less Than 1500g (Very Low Birth Weight): 1991-2002

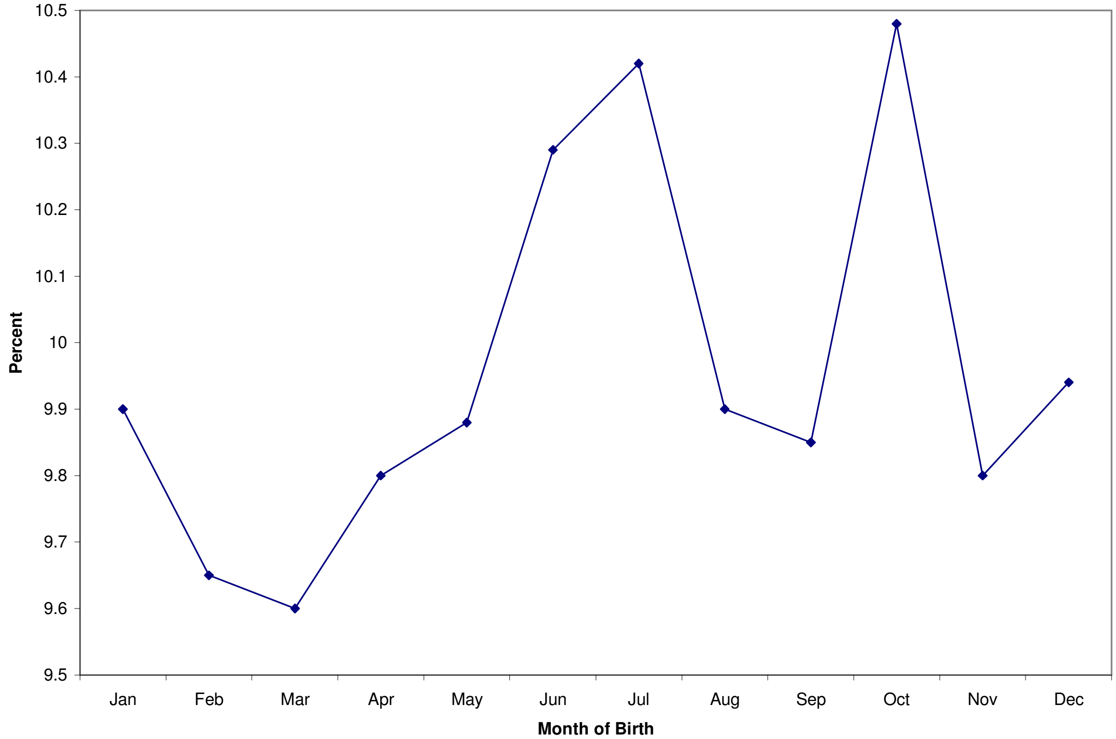

Figure 11

Mean Percent of Black GA Births Weighing 1500-2499g (Low Birth Weight): 1991-2002

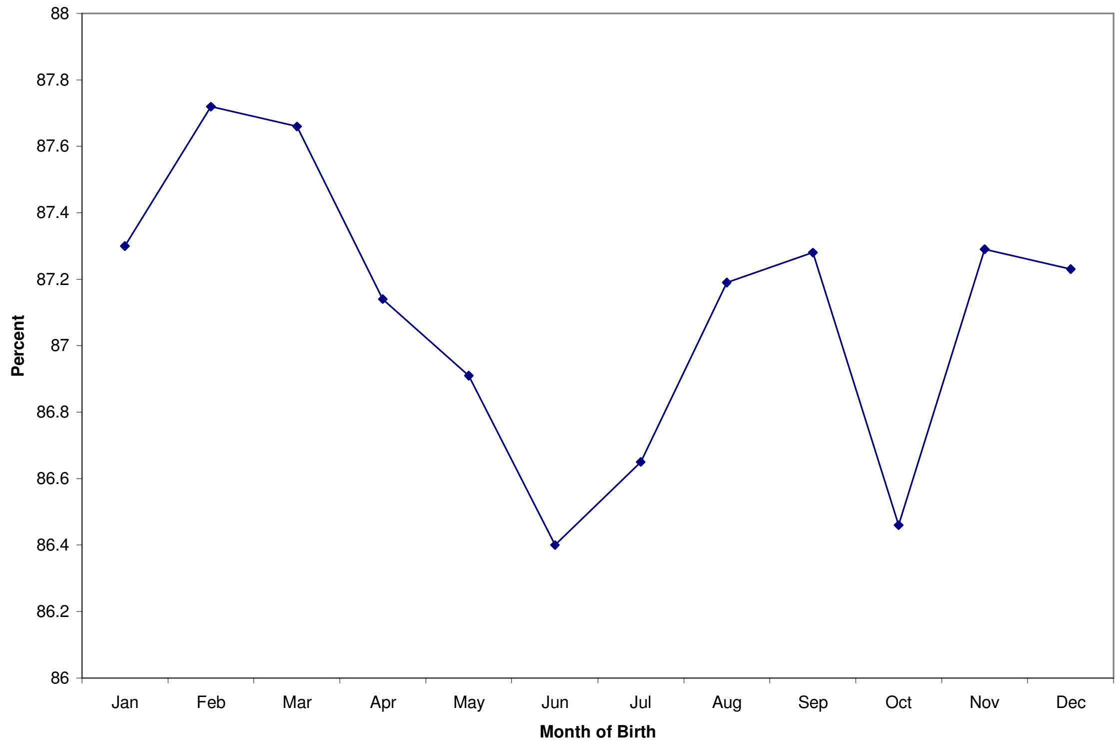

Figure 12

Mean Percent of Black GA Births Weighing More Than 2500g (Normal-High Birth Weight): 1991-2002

Table 11

Fetal Distress: White and Black Rate for Infants

	White		Black	
	Rate	SD	Rate	SD
Jan.	3.25%	.37	4.15%	.53
Feb.	3.29	.37	4.11	.43
Mar.	3.19	.35	3.97	.48
Apr.	3.20	.37	3.96	.32
May	3.07	.34	4.02	.40
Jun.	3.16	.33	3.82	.37
Jul.	2.95	.24	3.80	.32
Aug.	2.96	.20	3.86	.30
Sep.	2.97	.28	3.72	.34
Oct.	3.08	.34	3.81	.36
Nov.	3.00	.25	3.73	.34
Dec.	3.08	.31	3.84	.36
Average	3.10	.32	3.90	.40

Rate equals the number of births experiencing fetal distress divided by the total number of births; * = monthly rates that are greater than 5% than the total average rate.

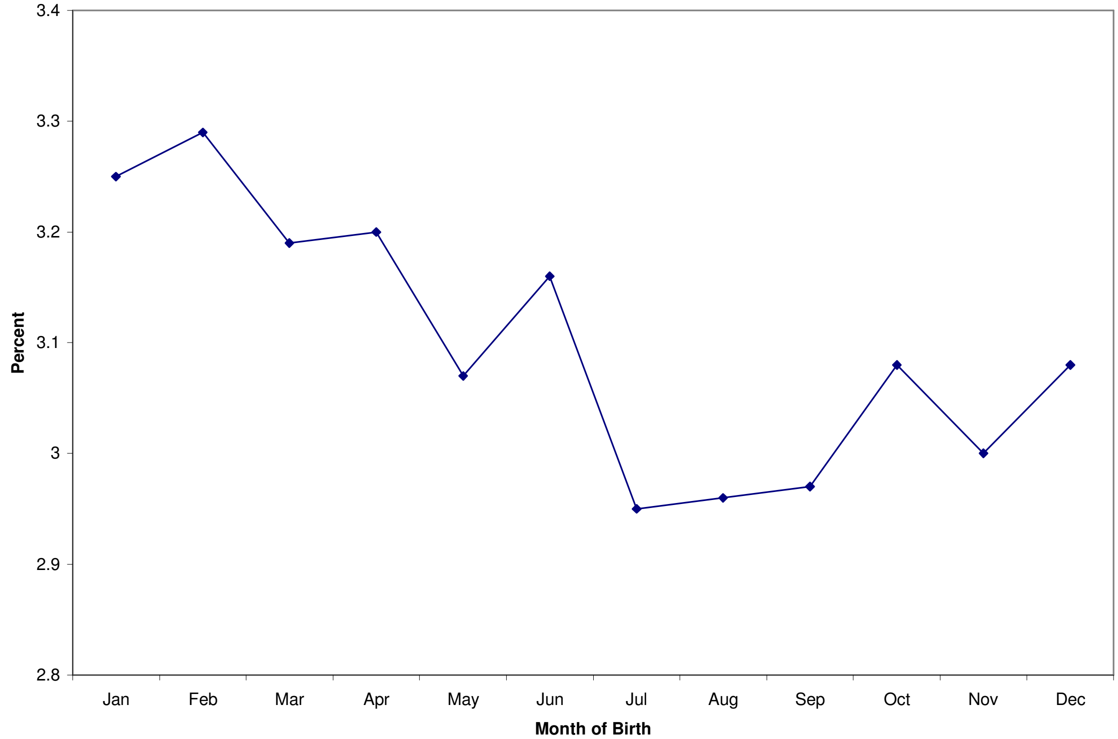

Figure 13

Mean Percent of White GA Births Experiencing Fetal Distress: 1991-2002

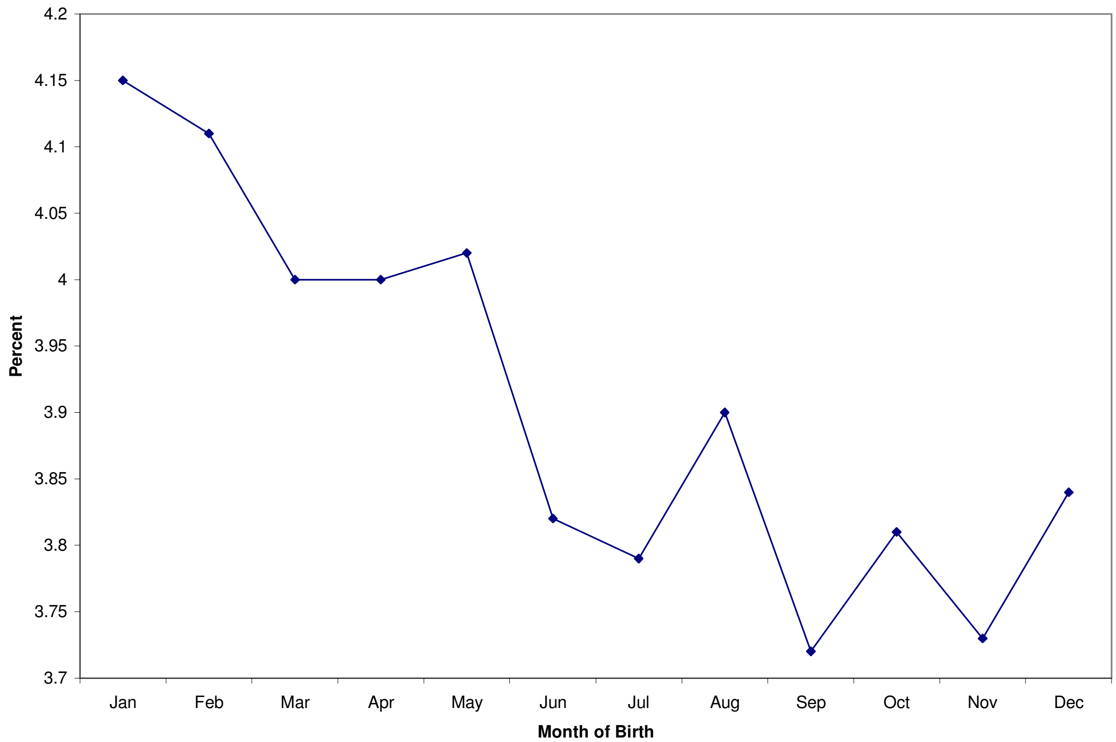

Figure 14

Mean Percent of Black GA Births Experiencing Fetal Distress: 1991-2002

Other Complications at Delivery

It was hypothesized that for white and black children, those born experiencing other complications at delivery would be born with greater than expected frequency in the late spring and summer months. Data relevant to this hypothesis are presented in Table 12 and figures 15 and 16.

An inspection of the mean birth rates of white children born experiencing other complications at delivery did not reveal any significant birth peaks. Spectral analysis was then conducted and revealed that there was a significant 12-month cycle (11% of variance explained, $p<.05$). However, the peaks and nadirs in this cycle were less than 8% above and below the mean.

An inspection of the mean birth rates of black children born experiencing other complications at delivery also did not reveal any meaningful birth peaks. Spectral analysis revealed no significant cycles.

Breech Delivery

It was hypothesized that for white and black children, those with breech position births would be born with greater than expected frequency in the late winter and summer months. Data relevant to this hypothesis are presented in Table 13 and figures 17 and 18.

An inspection of the mean birth rates of white children born experiencing with breech position births did not reveal any meaningful birth peaks greater than 8% above the mean. Spectral analysis revealed no significant cycles.

An inspection of the mean birth rates of black children born experiencing breech position births did not reveal a significant birth peak. Spectral analysis revealed no significant cycles.

Ventilation Administered at Less Than 30 Minutes Following Delivery

It was hypothesized that for white and black children, those administered artificial ventilation at less than 30 minutes following delivery would be born with greater than expected frequency in the late winter and summer months. Data relevant to this hypothesis are presented in Table 14 and figures 19 and 20.

An inspection of the mean birth rates of white children did not reveal a birth peak greater than 8% of the total mean rate, although a meaningful nadir was found to exist in September (11% less than the mean birth rate). Spectral analysis demonstrated that there was a significant 12-month cycle (24% of variance explained, $p<.05$).

An inspection of the mean birth rates of black children administered artificial ventilation at less than 30 minutes following delivery revealed that births peak between the summer months of May, June, and July (12.6%, 8.8%, and 8.8% greater than the mean, respectively), and decline meaningful in January and September (9% below the mean for both months). Spectral analysis revealed a significant 12-month cycle (10% variance explained, $p<.05$).

Ventilation Administered at More Than 30 Minutes Following Delivery

It was hypothesized that for white and black children, those administered artificial ventilation at more than 30 minutes following delivery would be born with greater than expected frequency in the late winter and summer months. Data relevant to this hypothesis are presented in Table 15 and figures 21 and 22.

An inspection of the mean birth rates of white children administered artificial ventilation at more than 30 minutes following delivery did not reveal a birth peak greater than 8% of the total mean rate. Spectral analysis also revealed no significant cycles.

An inspection of the mean birth rates of black children revealed meaningful peaks in May and June (7.3% and 10.4%, respectively) and another in October and November (both 9.3% above the mean). However, spectral analysis revealed these peaks did not occur in significant cycles.

Summary

In general, meaningful birth peaks in the adjusted rates of infants assigned these anomalies occurred in the late winter and/or summer months as was hypothesized (Table 16). However, nadirs were less consistently found in the fall months, although both white and black infants receiving ventilation at less than 30 minutes following delivery demonstrated September nadirs. All birth peaks and nadirs occurred at rates greater than 8% from the mean birth rate totals. This study also found significant annual (12 month) cycles for black infants born at very low (less than 1500g) birth weight, black infants born at normal-high (greater than 2500g) birth weight, white infants born with other complications at delivery, and black and white infants receiving ventilation at less than 30 minutes after delivery. In addition, a significant 6 month cycle was found for white infants receiving middle range (4-6) Apgar scores.

Table 12

Other Complications at Delivery: White and Black Rate for Infants

	White		Black	
	Rate	SD	Rate	SD
Jan.	12.88%	.73	13.78%	.7
Feb.	13.39	.68	13.83	.99
Mar.	13.30	.76	13.82	.57
Apr.	13.16	.60	13.44	.50
May	13.38	.51	13.88	.59
Jun.	13.06	.73	13.57	.62
Jul.	13.46	.66	13.70	.94
Aug.	13.44	.38	13.59	.63
Sep.	13.39	.74	13.85	.40
Oct.	13.08	.74	13.79	.62
Nov.	13.54	.69	14.19	.73
Dec.	13.44	.88	13.63	.81
Average	13.29	.69	13.75	.70

Rate equals the number of births assigned other complications at delivery divided by the total number of births; * = monthly rates that are greater than 8% than the total average rate.

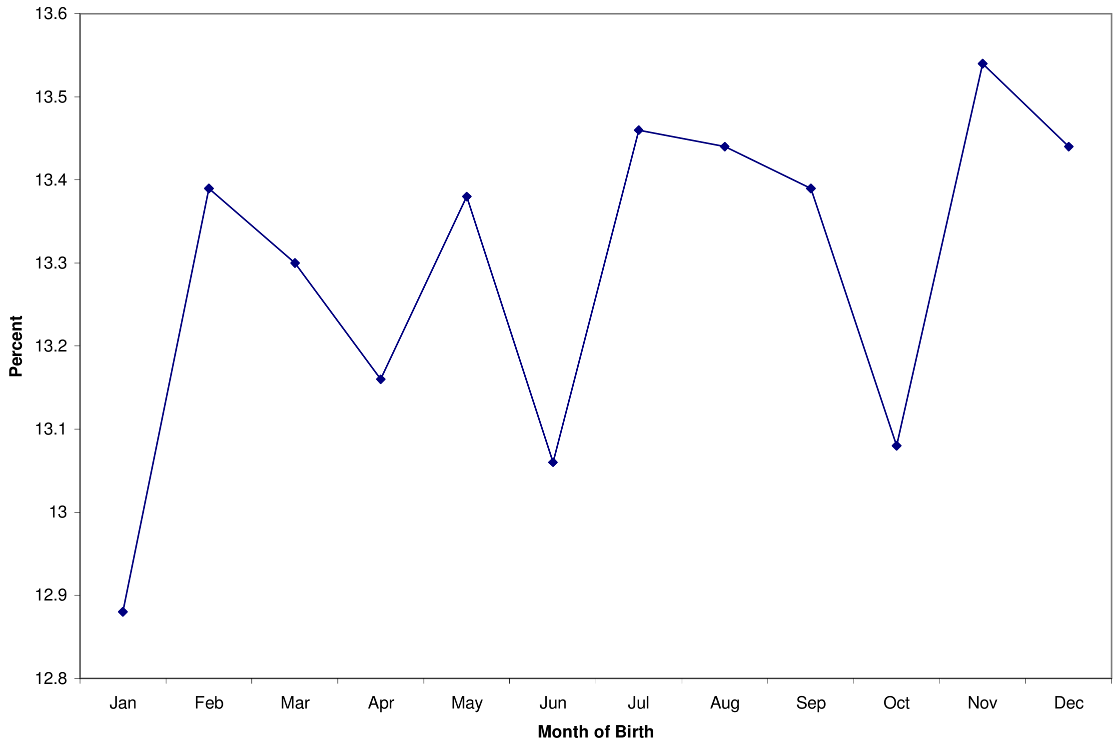

Figure 15

Mean Percent of White GA Births Experiencing Other Complications at Delivery: 1991-2002

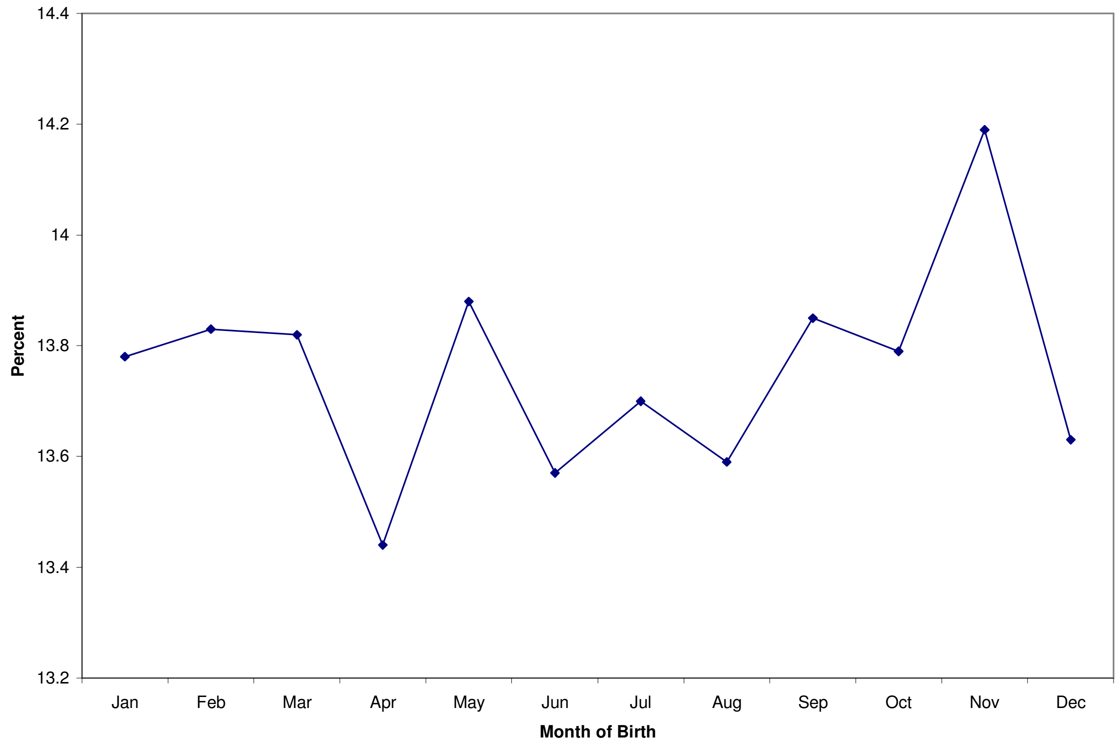

Figure 16

Mean Percent of Black GA Births Experiencing Other Complications at Delivery: 1991-2002

Table 13

Breech Birth Delivery: White and Black Rate for Infants

	White		Black	
	Rate	SD	Rate	SD
Jan.	3.57%	.31	2.49%	.29
Feb.	3.72	.21	2.46	.27
Mar.	3.75	.34	2.44	.19
Apr.	3.75	.22	2.52	.25
May	3.60	.27	2.62	.31
Jun.	3.66	.29	2.71	.28
Jul.	3.62	.17	2.51	.28
Aug.	3.48	.28	2.62	.29
Sep.	3.47	.28	2.55	.37
Oct.	3.60	.22	2.70	.28
Nov.	3.66	.19	2.53	.34
Dec.	3.73	.34	2.55	.34
Average	3.64	.27	2.56	.29

Rate equals the number of births delivered in breech position divided by the total number of births; * = monthly rates that are greater than 8% than the total average rate.

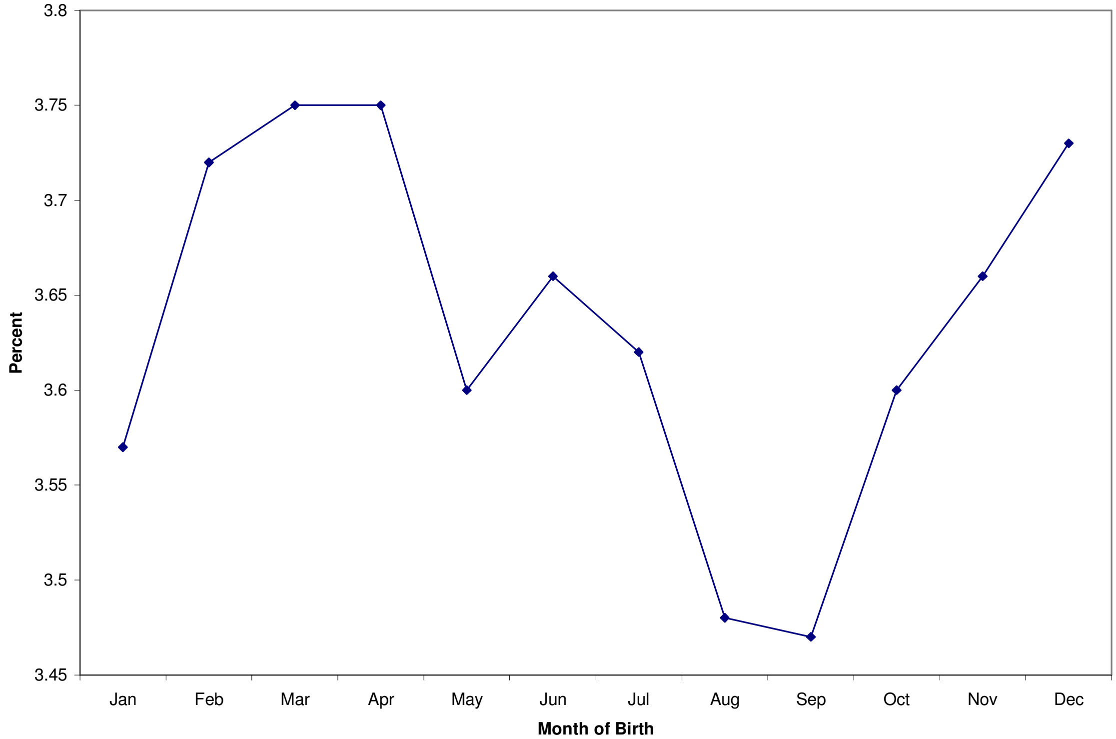

Figure 17

Mean Percent of White GA Births Delivered in Breech Position: 1991-2002

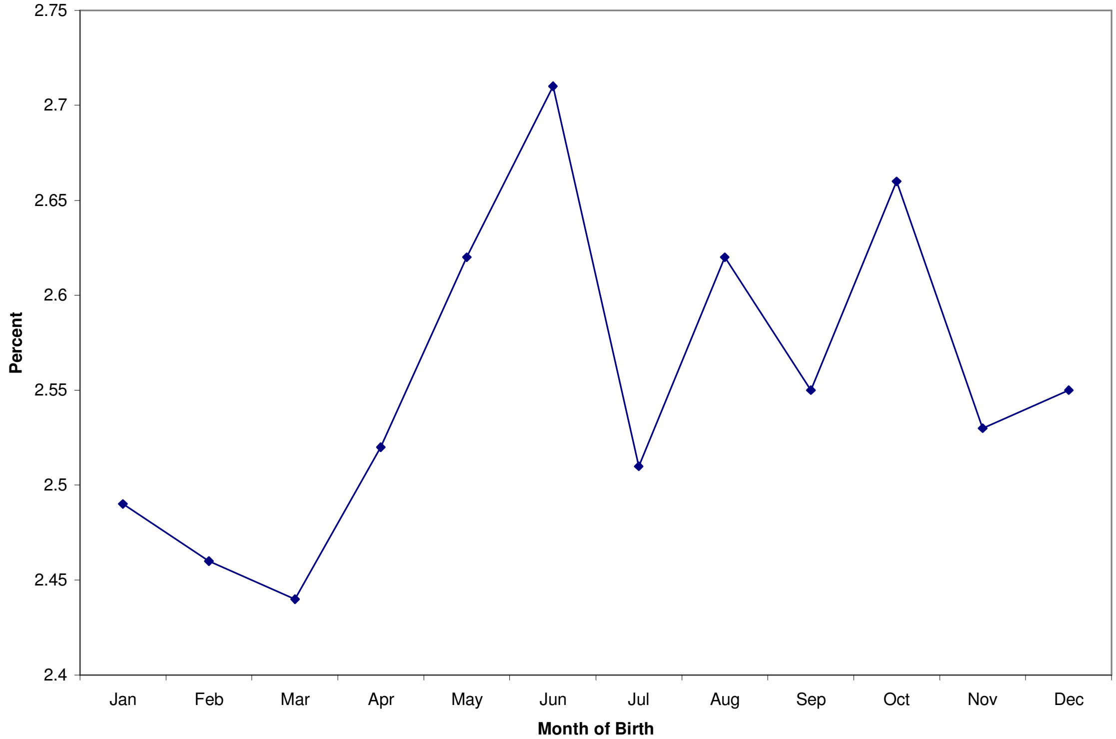

Figure 18

Mean Percent of Black GA Births Delivered in Breech Position: 1991-2002

Table 14

Ventilation Received Less Than 30 Minutes Following Delivery: White and Black Rate for Infants

	White		Black	
	Rate	SD	Rate	SD
Jan.	1.52%	.32	2.16%	.82
Feb.	1.63	.44	2.40	.98
Mar.	1.60	.29	2.42	.38
Apr.	1.65	.25	2.33	.39
May	1.68	.29	2.68*	.40
Jun.	1.63	.32	2.59*	.50
Jul.	1.66	.25	2.59*	.37
Aug.	1.51	.41	2.27	.91
Sep.	1.42	.36	2.16	.76
Oct.	1.64	.34	2.32	.66
Nov.	1.59	.43	2.19	.80
Dec.	1.60	.38	2.39	.67
Average	1.59	.34	2.38	.67

Rate equals the number of births receiving ventilation divided by the total number of births; * = monthly rates that are greater than 8% of the total average rate.

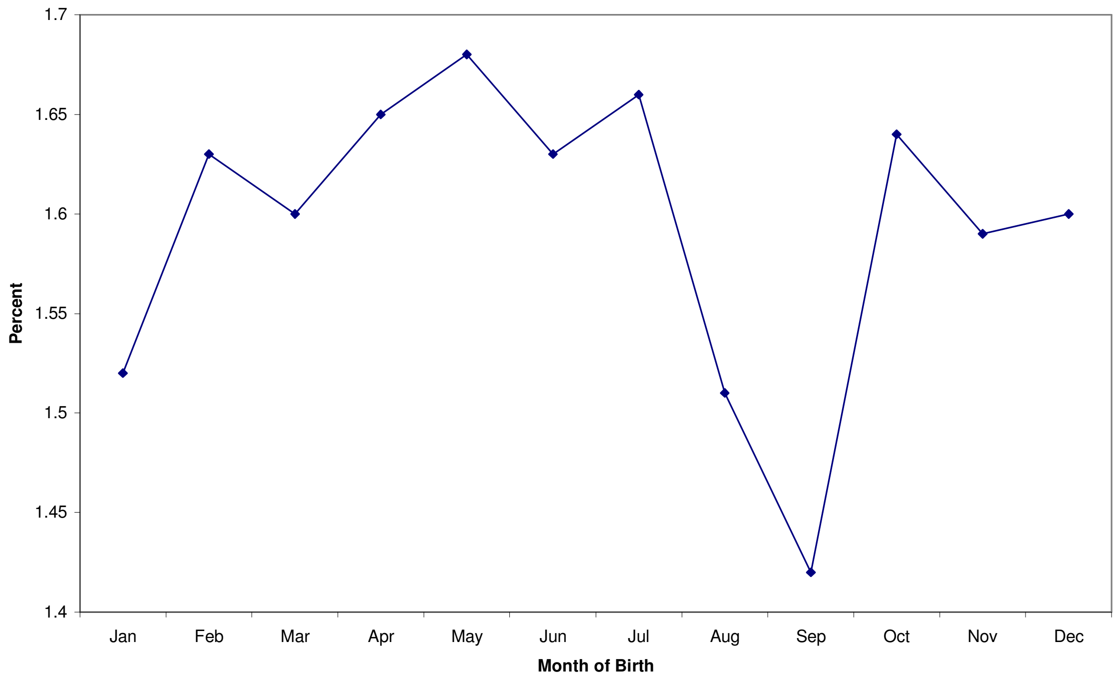

Figure 19

Mean Percent of White GA Births Receiving Artificial Ventilation at 30 Minutes or Less Following Delivery: 1991-2002

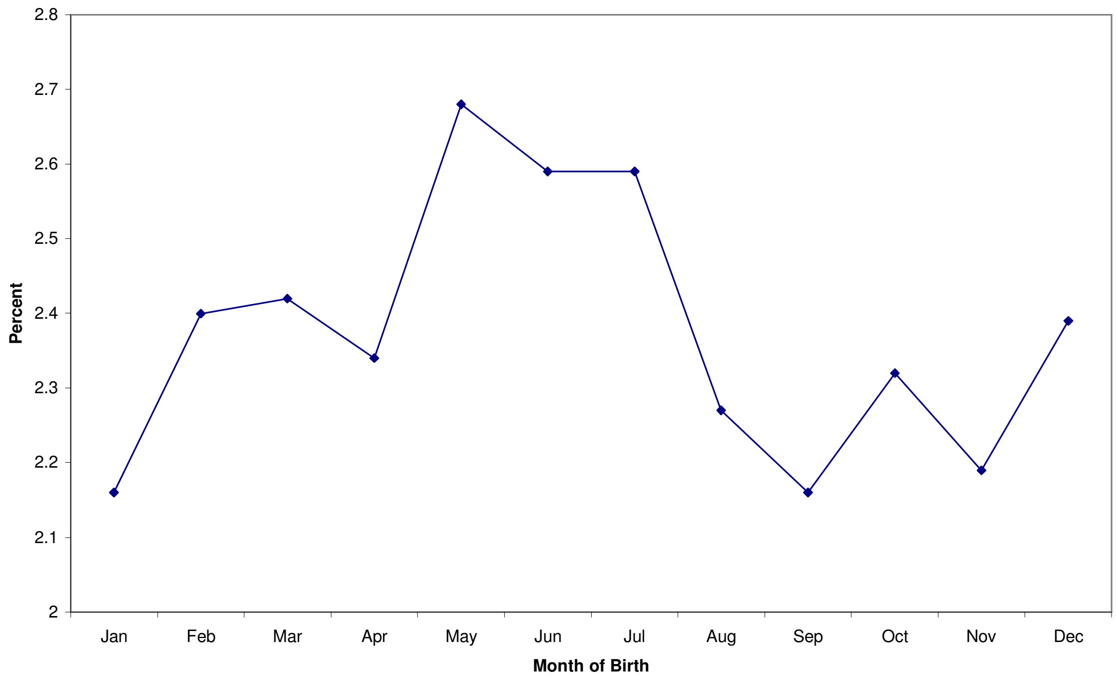

Figure 20

Mean Percent of Black GA Births Receiving Artificial Ventilation at 30 Minutes or Less Following Delivery: 1991-2002

Table 15

Ventilation Received More Than 30 Minutes Following Delivery: White and Black Rate for Infants

	White		Black	
	Rate	SD	Rate	SD
Jan.	.80%	.17	.92%	.20
Feb.	.81	.18	.88	.14
Mar.	.82	.10	.90	.15
Apr.	.77	.15	1.0	.20
May	.74	.13	1.03*	.29
Jun.	.80	.09	1.06*	.14
Jul.	.76	.10	.89	.19
Aug.	.73	.10	.91	.14
Sep.	.81	.13	.88	.19
Oct.	.79	.16	1.05*	.18
Nov.	.81	.22	1.05*	.36
Dec.	.76	.15	.89	.25
Average	.78	.14	.96	.22

Rate equals the number of births receiving ventilation divided by the total number of births; * = monthly rates that are greater than 8% of the total average rate.

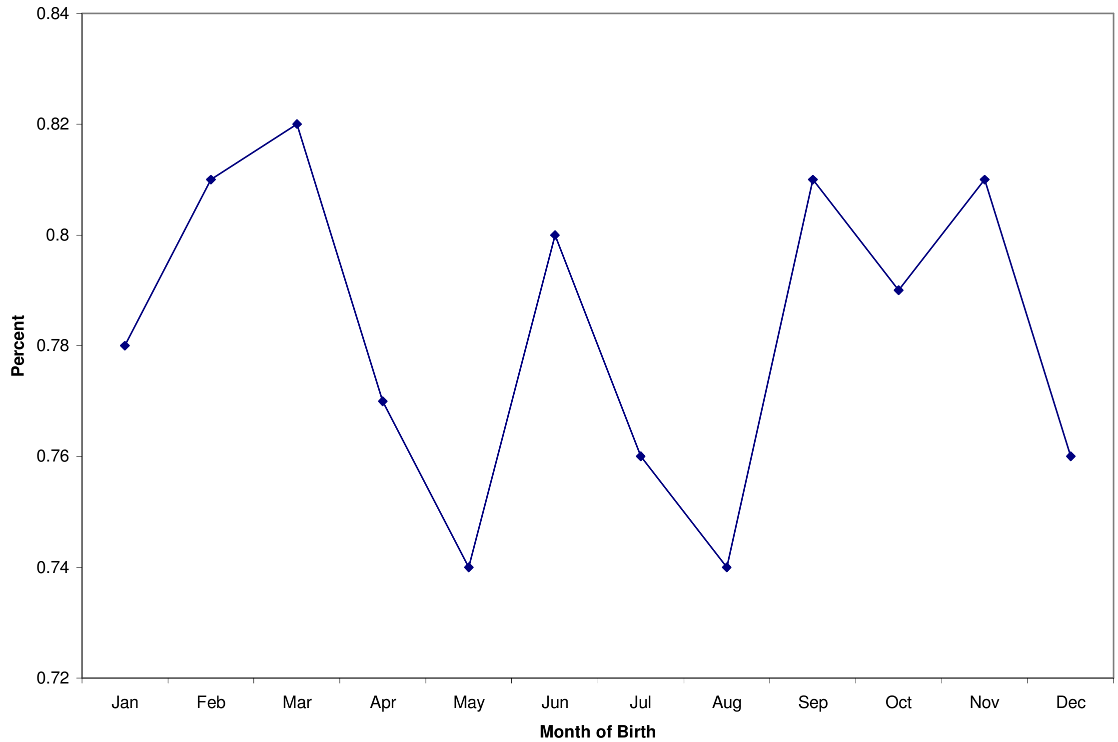

Figure 21

Mean Percent of White GA Births Receiving Artificial Ventilation at 30 Minutes or More Following Delivery: 1991-2002

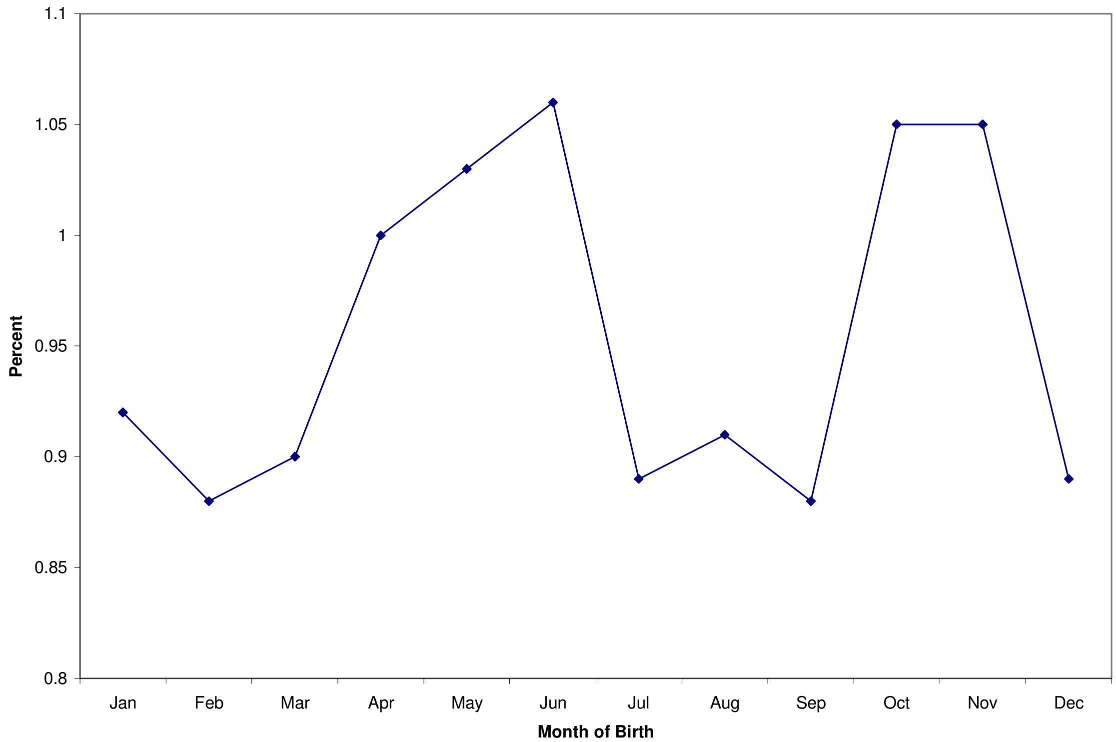

Figure 22

Mean Percent of Black GA Births Receiving Artificial Ventilation at 30 Minutes or More Following Delivery: 1991-2002

Table 16

Summary Table of Preliminary Results

Anomaly	Peak (+8%)[1]	Nadir (-8%)[2]	Significant[3]	Cycle
Apgar Scores				
White				
Low	Feb., Oct.	Jan., Mar.	n/a	
Middle	May, Jun.	Feb.	9.7%	6
High	none	none	n/a	
Black				
Low	Feb. Apr., May	Jan., Dec.	n/a	
Middle	Jul.	Feb.	n/a	
High	none	none	n/a	
Birth Weight				
White				
Very Low	Jun.	none	n/a	
Low	none	none	n/a	
Normal-high	none	none	na	
Black				
Very Low	May, Jun.	Feb.	14.11%	12
Low	none	none	n/a	
Normal-high	none	none	13.23%	12

Fetal Distress				
White	none	none	n/a	
Black	none	none	n/a	
Other Complications				
White	none	none	11%	12
Black	none	none	n/a	
Breech Delivery				
White	none	none	n/a	
Black	none	none	n/a	
Ventilation Given at Less Than 30 Minutes				
White	none	Sep.	24%	12
Black	May, Jun., Jul.	Jan., Sep.	10%	12
Ventilation Given at More Than 30 Minutes				
White	none	none	n/a	
Black	May, Jun., Oct., Nov.	none	n/a	

[1]Peak months are greater than 8% of the total mean for all months; [2]Nadir months are more than 8% less than the mean for all months; [3]$p<.05$.

CHAPTER 5

DISCUSSION

Research Implications

The first question posed in this study asked: were any meaningful monthly variations in birth patterns for any of the groupings of perinatal anomalies studied, and if so, when did these variations occur? The adjusted rate of perinatal anomalies that demonstrated meaningful (greater than 8% different from the mean) birth variation included: Apgar scores in the ranges of 0-3 and 4-6 for white and black infants, very low birth weight for white and black infants, ventilation given at less than 30 minutes for black and white infants, and ventilation given at greater than 30 minutes following delivery for black infants (see Table 16).

The original hypothesis stated that analysis of the monthly birth rates of the six perinatal events will reveal two meaningful peaks: late winter (February/March) and summer (June, July, and August). Table 16 shows that, in general, those anomalies that demonstrated as having meaningful birth peaks had them at these times. For example, white and black low Apgar scores had peaks in February; white middle range Apgar scores had peaks in May and June while black scores had a peak in July; white very low birth weight infants peaked in June while black infants peaked in May and June; black infants given ventilation at less than 30 minutes after delivery had meaningful peaks in May, June, and July; black infants given ventilation at more than 30 minutes after delivery had meaningful peaks in May and June. However, it is important to note that several of these anomalies also had peaks in months other than the late winter and summer.

The second question asked: were anomaly birth rate peak and nadir periods the same for white and black infants? Although not every anomaly had meaningful birth rate peaks and nadirs, several of those that did had similar ones for the white and black samples. For example, inspection of Table 16 shows that 0-3 Apgar scores for white and black infants had peaks in February and nadirs in January. White and black middle range Apgar scores (4-6) both had summer peaks, although the white peaks were in May and June while the black peak occurred in July. Like the low Apgar scores, white and black middle range Apgar scores also had nadirs in February. An inspection of Table 16 reveals that rates of white and black infants born at very low birth weight peak in June; black rates also had a meaningful peak in May. White and black infants who received ventilation for a period at less than 30 minutes following delivery had similar nadirs in September; black infants also had a meaningful nadir in January.

The third question asked: of those anomalies that did have meaningful monthly variations in birth patterns, did the peaks and nadirs occur in significant cycles? White middle range Apgar scores (May and June peaks) were found to have a birth pattern that occurred at a significant level for a 6 month cycle. Black very low birth weight (May and June peaks) was found to have a birth pattern that occurred at a significant level for a 12 month, or annual cycle. White infants receiving ventilation at less than 30 minutes (September nadir) were found to have a birth pattern that occurred at a significant level for a 12 month cycle. Black infants receiving ventilation at less than 30 minutes (May, June, July peaks) were found to have a birth pattern that occurred at a significant level for a 12 month cycle, as were black infants receiving ventilation at more than 30 minutes (May, June, October, November peaks). Black normal-high birth weight infants and white infants receiving ventilation at less than 30 minutes were two anomalies without meaningful peaks or nadirs that were found to have significant annual cycles. It is important to recognize that not all anomalies demonstrated variable birth patterns that occurred in significant cycles.

These findings are similar to that of previous research which found that children with dyslexia, specific learning disabilities, speech-language impairment and internalizing problems were born in greater than expected frequency in the summer months of June, July, and August and children with more severe pathologies were born in the late winter months of February and March. Hypotheses for such increased birth rates of children have been attributed to several causes. The maturity hypothesis states that children born in the summer months (just prior to fall school entry dates) have a physically less developed CNS because they are nearly 12 months younger than their peers. This maturational difference in children results in weaker executive functioning (Barkley, 1998), selective attention (Miller, 1991) and metacognition (Garner, 1991), all performance areas that are deemed vital to successful schooling. The self-concept hypothesis states that young-in-grade children (those born during the spring and summer) are at a social disadvantage compared to their older peers. These children are often less physically developed and socially skilled. Taken cumulatively, such deficits can result in lowered self-esteem or self-concept, which can lead to lower achievement when compared to older, same-grade peers (Pellegrini, 1992). That this study consistently found meaningful birth peaks in the early summer (May, June, and July) but not the late summer (August) may reflect how infants are not subject to the possible deleterious effects that physical immaturity and poor self-concept can have on a school-age child.

A third explanation for the meaningful May-July birth rate peaks is the gestational hypothesis. This hypothesis states that since upper-respiratory infections and influenza are more prevalent in the winter months (Glezen & Couch, 1997), these bacteria and viruses are passed by the mother to the child at a greater than expected rate. These infections may impair fetal CNS development (Mednick et al., 1998; Takei et al., 1995) which, though not resulting in a visible teratogenic effect, is manifested in increased rates of learning and behavior problems when the child is challenged with difficult learning tasks such as at the beginning of formal schooling. An alternate prenatal perturbation hypothesis is the vitamin D hypothesis. This hypothesis asserts that pregnant women in the second trimester during the winter months are subject to less sunlight exposure and thus less vitamin D synthesis. Vitamin D has been shown to be related to several processes that affect CNS development (Eyles et. al., 2003).

Still another possible explanation for this study’s finding that the majority of birth peaks, when they did occur, occurred in April-July may be related to the overall birth pattern of children born in the southern United States. The birth pattern in the northern United States has a winter nadir between November and January that steadily increases to a birth peak in May and June. The birth pattern in the north resembles a sine curve. The birth pattern in the south also has a winter nadir between November-January. However, instead of increasing to a peak in May and June, the pattern sags in April and May before steadily rising to a peak in September (Lam & Miron, 1994). This dip in the birth pattern in April and May might reflect fewer conceptions occurring in the summer months, possibly due to the increased heat of the season. Conceptions then increase in winter when the temperature cools. Since more births in the south occur in September, more premature babies will be born in the late spring and summer months. The increased premature births are an "echo effect" of the increased September births in the general population. Prematurity may be associated with the finding of greater than expected birth rates of children born with perinatal anomalies in the late spring and summer months.

It is important to note that there were some ethnic/racial differences in the rates of anomalies. For example, black very low birth weight infants demonstrated meaningful birth peaks in May and June, while white very low birth weight infants meaningfully peaked in June only. Further, while not always demonstrating birth peaks and birth pattern cycles at significant levels, overall birth rates of black infants born with low and middle range Apgar scores, fetal distress, other complications at delivery, and receiving ventilation were consistently greater than those of white infants. One possible explanation for higher black birth rates of perinatal anomalies could be that in general, blacks in Georgia are more representative of low socio-economic status. Therefore, they have greater exposure to environmental influences that might increase winter prenatal perturbations and result in greater rates of perinatal complications. Thus, the differences between white and black rates of perinatal anomalies are more likely to be differences in socioeconomic status, rather than race or ethnicity. Another possible explanation for the discrepancy in rates between white and black infants might be associated with the vitamin D hypothesis. Due to differences in skin pigmentation, blacks tend naturally to be more vitamin D deficient than whites if exposed to sunlight at the same rates. This deficiency is especially true in the winter months, when all mothers tend to experience less vitamin D synthesis due to less sun exposure. Thus, in the winter, black fetuses receive even less vitamin D during this critical period of CNS development, resulting in greater rates of perinatal anomalies compared to white infants born at the same time.

While meaningful results were found for 9 of the perinatal anomaly groupings, it is important to discuss that significant birth cycles and meaningful peaks were not found for black high Apgar scores, white low and normal-high birth weights, white and black fetal distress, white and black breech delivery, white ventilation given at 30 minutes or greater following delivery, or white and black infants experiencing other complications at delivery.

Practical Implications

Results from this study raise particular concerns. This study demonstrates that birth rates of infants with certain perinatal anomalies follow the same general birth pattern of children found to have learning or behavioral problems in school. Decreasing the rates of perinatal anomalies may result in a decrease in the number of children with learning and behavior problem, and thus the number of children receiving special education services. This reduction would have an economic benefit to the State, since students who receive special education services use greater resources and require more funding than their non-special education peers. Therefore, it is important to better understand the biological risks associated with late spring and summer births and to try to intervene with appropriate public health policy.

A second consideration is that children born with perinatal anomalies in the late spring and summer months are placed in double jeopardy. They are at risk for developing learning and behavioral problems due to increased biological risks while also being the least physically and socially mature children in their grades. Moving the school entry cut-off date from September 1st to January 1st would mean that children born with perinatal anomalies would no longer be the youngest children in their grade. If the prenatal insult hypotheses of gestational infection and/or the vitamin D deficiency are true, these children would still have biological risks of developing learning and behavior problems while being spared social and self-concept risks associated with learning and behavioral problems in school.

Limitations

This study selected several birth anomalies that seemed likely to be associated with seasonal factors and did not analyze all perinatal anomalies. Thus, it is not known to what extent other anomalies vary by season. In addition, this study did not analyze premature births, although the closely associated variables very low and low birth weights were. This study is limited by the quality of natality data provided to the federal government. In most instances, the presiding physicians complete records for anomalous events at birth that are recorded by the neonatal clerk. The reliability of this information is not known. A further limitation of this study is that it uses only Georgia natality data. This limits the generality of the findings. Special education data used in this study were culled from 54 participating counties in Northeast Georgia out of a possible 159. However, it is important to note that these data do represent approximately 50% of the total special education population in Georgia and are thought to be representative. Last, there is a marked, unexpected increase in the frequency of white and black infants who needed artificial ventilation for a period of time less than 30 minutes following delivery for the years 1993-1997. This increase in frequency is unexplained at this time.

Implications for Future Research

Future research should study northern geographic locations that do not have a generalized September birth peak. This would help determine if the increased birth rates of infants with perinatal anomalies in late spring and summer is associated with an echo effect from the south's general September birth peak. Also, future research should examine high socio-economic status African-Americans to better determine if low SES has an effect on the birth rates of black infants with perinatal anomalies. In addition, a wider range of birth anomalies should be studied, including premature births. Last, due to the evidence of seasonally fluctuating rates of consumption of alcohol and other substances, future research should investigate associations between such rates and the seasonal birth rates of perinatal anomalies and psychopathologies.

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APPENDIX A

Mean birth totals of perinatal anomalies

Table A-1

Apgar Scores[1]: Mean Number of Births: 1995-2002

		Mean Number of Births	Standard Deviation	Birth Rate
0				
	White	2.67	1.83	.05[2]
	Black	3.24	1.79	.10
1				
	White	6.74	2.60	.12
	Black	12.64	3.76	.37
2				
	White	3.36	1.77	.06
	Black	5.67	2.50	.17
3				
	White	4.22	2.20	.07
	Black	6.18	2.41	.18
4				
	White	6.33	2.40	.11
	Black	7.90	3.04	.23
5				
	White	11.52	3.21	.20
	Black	14.02	3.82	.41

6			
White	24.19	5.43	.42
Black	28.00	5.61	.82
7			
White	68.48	8.44	1.20
Black	57.27	9.17	1.70
8			
White	374.22	29.01	6.56
Black	234.78	22.12	6.90
9			
White	4722.38	278.91	82.68
Black	2824.46	245.45	82.93
10			
White	464.61	87.08	8.16
Black	186.96	34.11	5.54

[1]5 minute Apgar score was used [2] Birth rate equals the number of births with this Apgar score divided by the total number of births

Table A-2

Birth Weight: Mean Number of Births: 1991-2002

	Mean Number of Births	Standard Deviation	Birth Rate
Less Than 1000g			
White	28.39	6.05	.50[1]
Black	54.89	8.44	1.63
1000-1499g			
White	33.87	8.03	.60
Black	44.71	8.90	1.32
1500-2002g			
White	73.03	11.94	1.30
Black	82.60	11.07	2.45
2000-2499g			
White	235.00	30.13	4.17
Black	253.32	25.93	7.51
2500-2999g			
White	827.65	100.42	14.68
Black	803.53	69.53	23.82
3000-3499g			
White	2031.92	112.73	36.08
Black	1296.36	105.22	38.42

3500-3999g			
White	1751.21	98.33	31.10
Black	670.70	49.44	19.90
4000-4499g			
White	552.12	38.46	9.81
Black	142.41	13.90	4.23
4500-4999g			
White	90.75	13.80	1.62
Black	20.85	4.70	.62
5000-8165g			
White	9.51	3.20	.17
Black	2.81	1.74	.08

[1]Birth rate equals the number of births at this weight divided by the total number of births

Table A-3

Other Perinatal Anomalies: Mean Number of Births: 1991-2002

	Mean Number of Births	Standard Deviation	Birth Rate
Fetal Distress			
White	173.76	33.60	3.10
Black	130.29	21.30	3.90
Other Complications			
White	751.30	166.80	13.30
Black	466.65	89.48	13.79
Breech Delivery			
White	205.85	18.75	3.66
Black	86.26	14.21	2.55
Ventilation for Less Than 30 Minutes			
White	88.87	49.90	1.60
Black	77.63	62.61	2.40
Ventilation for More Than 30 Minutes			
White	44.40	10.81	.79
Black	31.81	9.50	.95

[1]Birth rate equals the number of births with these anomalies divided by the total number of births

APPENDIX B

Box plots of perinatal anomaly birth rates

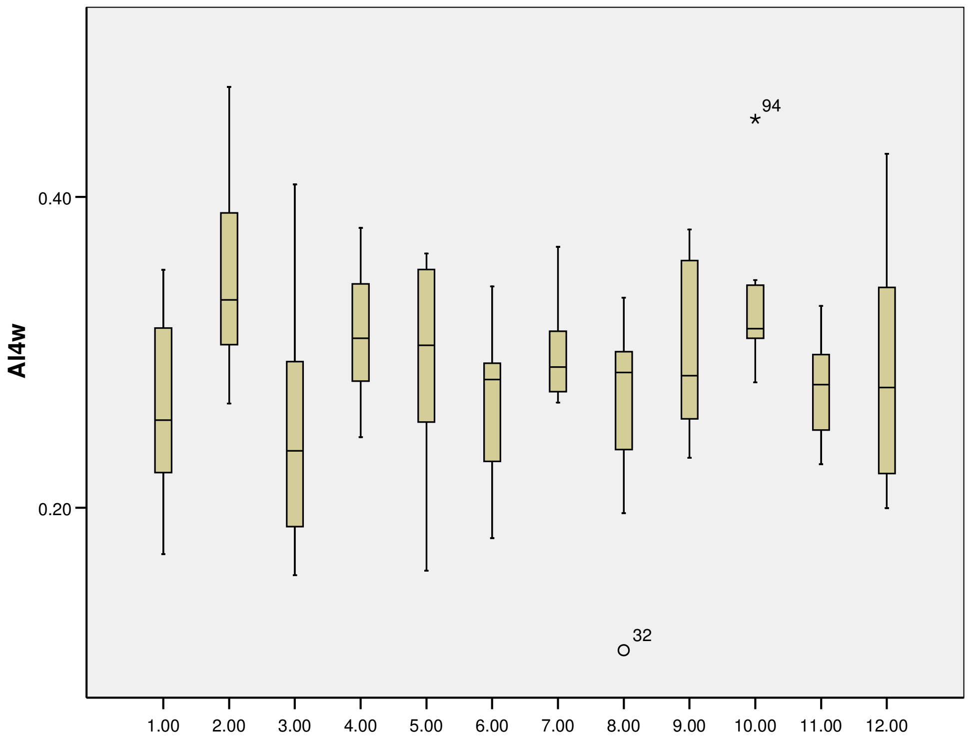
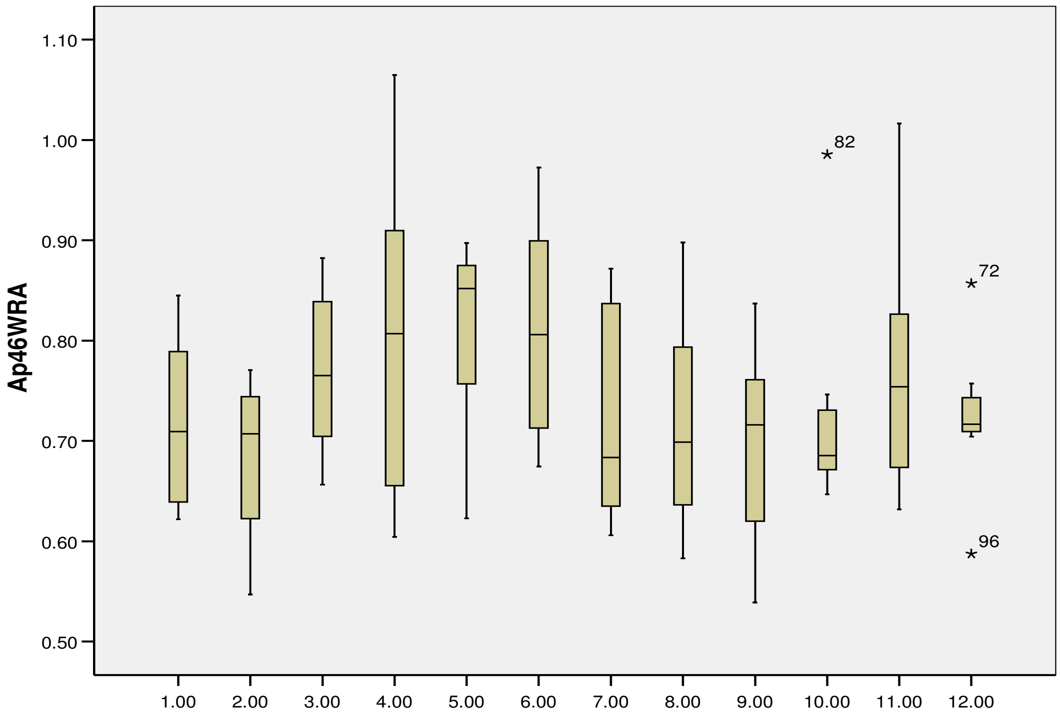


Figure B1

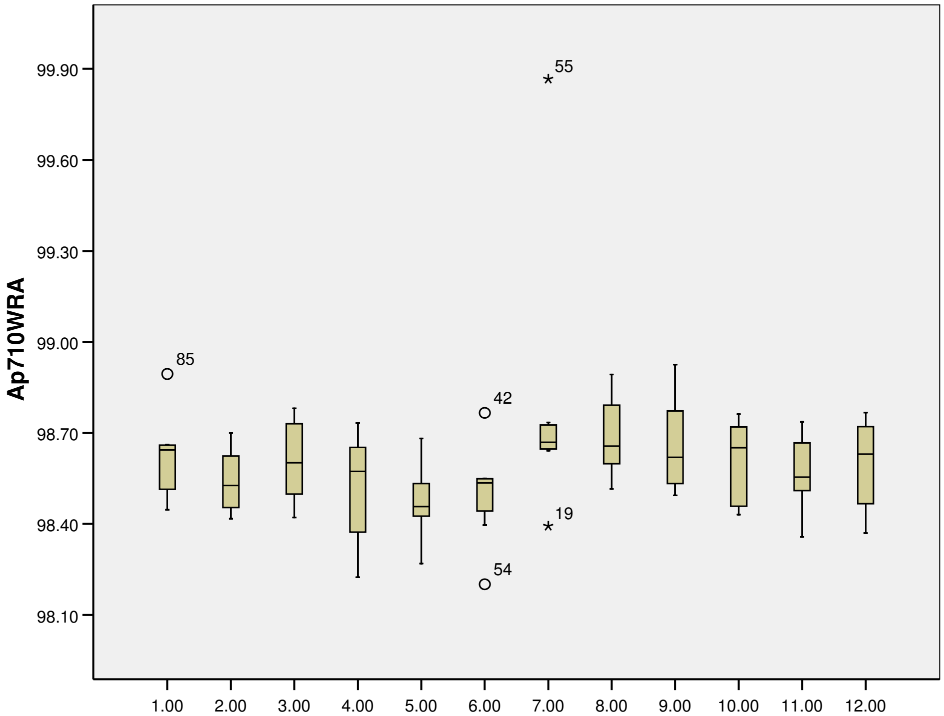
Rate of White GA Births Receiving Apgar Scores 0-3: 1995-2002



Vertical axis = rate of births in which these Apgar scores were assigned; horizontal axis = month of birth, 1= January

Figure B-2

Rate of White GA Births Receiving Apgar Scores 4-6: 1995-2002



Vertical axis = rate of births in which these Apgar scores were assigned; horizontal axis = month of birth, 1= January

Figure B-3

Rate of White GA Births Receiving Apgar Scores 7-10: 1995-2002

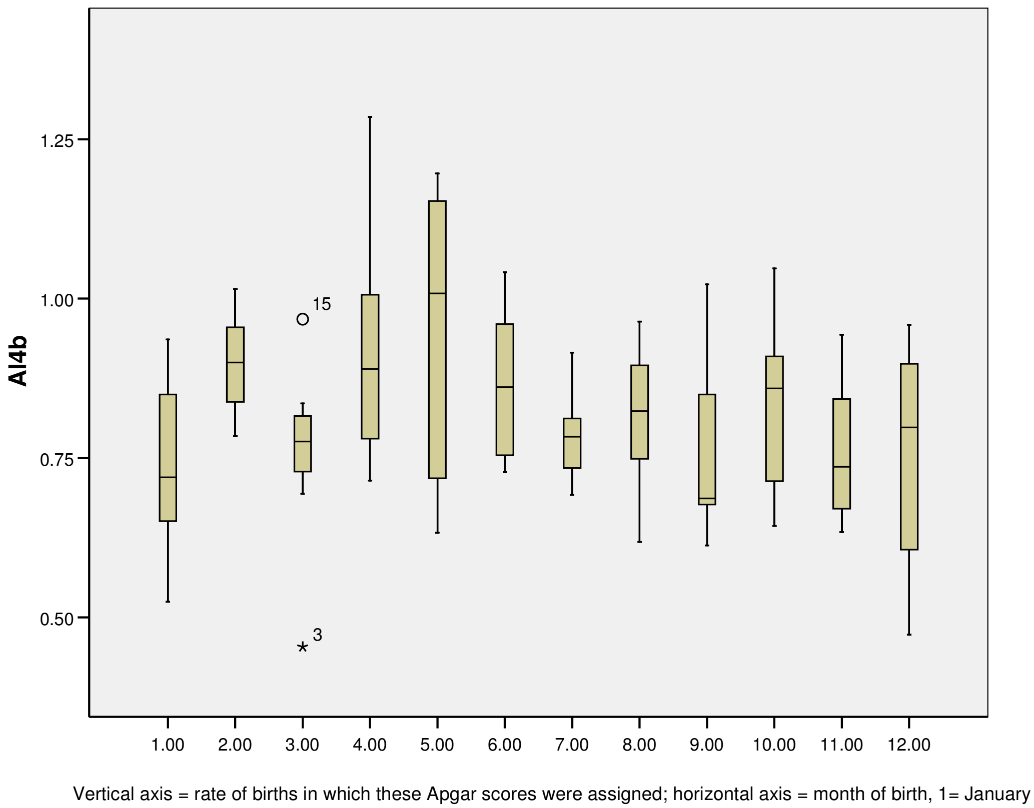


Figure B-4

Rate of Black GA Births Receiving Apgar Scores 0-3: 1995-2002

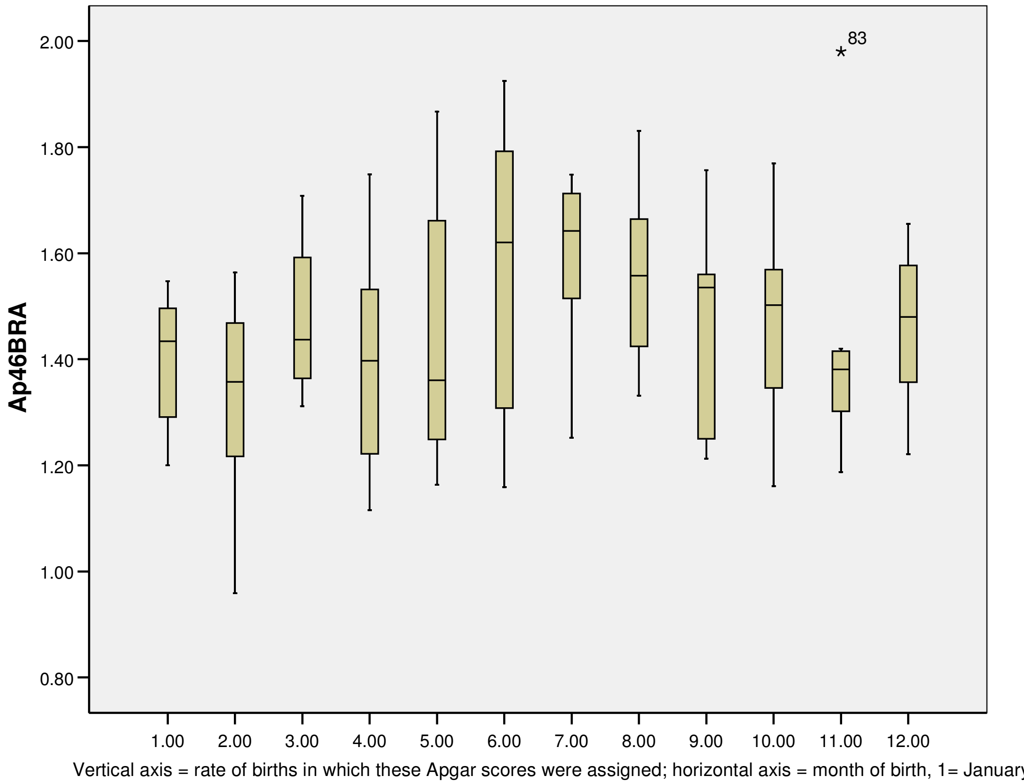
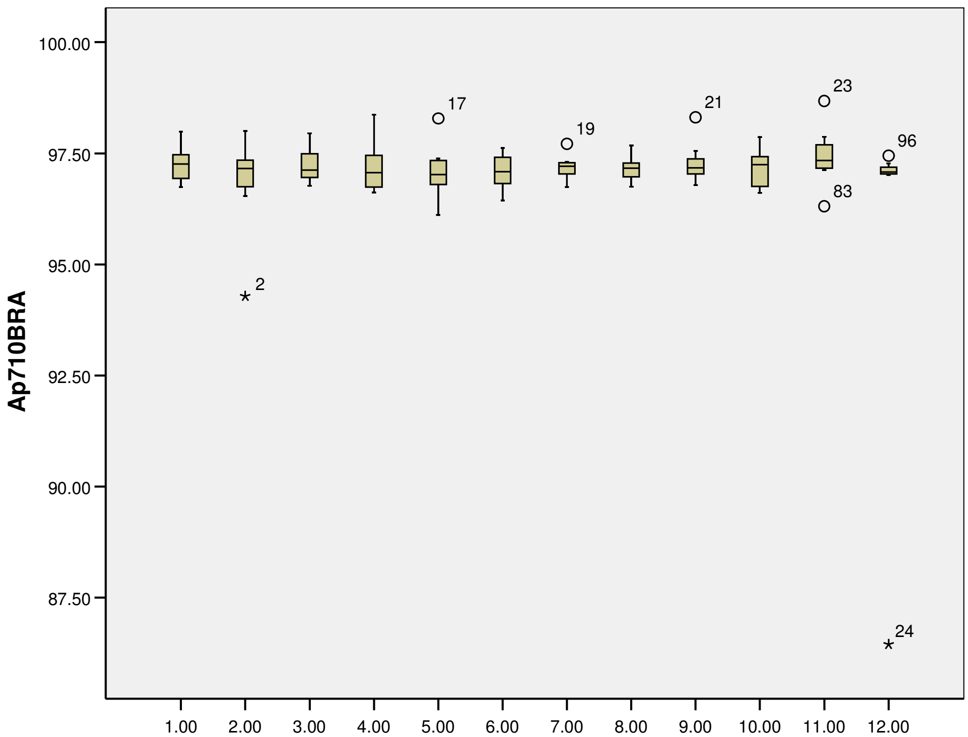


Figure B-5

Rate of Black GA Births Receiving Apgar Scores 4-6: 1995-2002



Vertical axis = rate of births in which these Apgar scores were assigned; horizontal axis = month of birth, 1= January

Figure B-6

Rate of Black GA Births Receiving Apgar Scores 7-10: 1995-2002

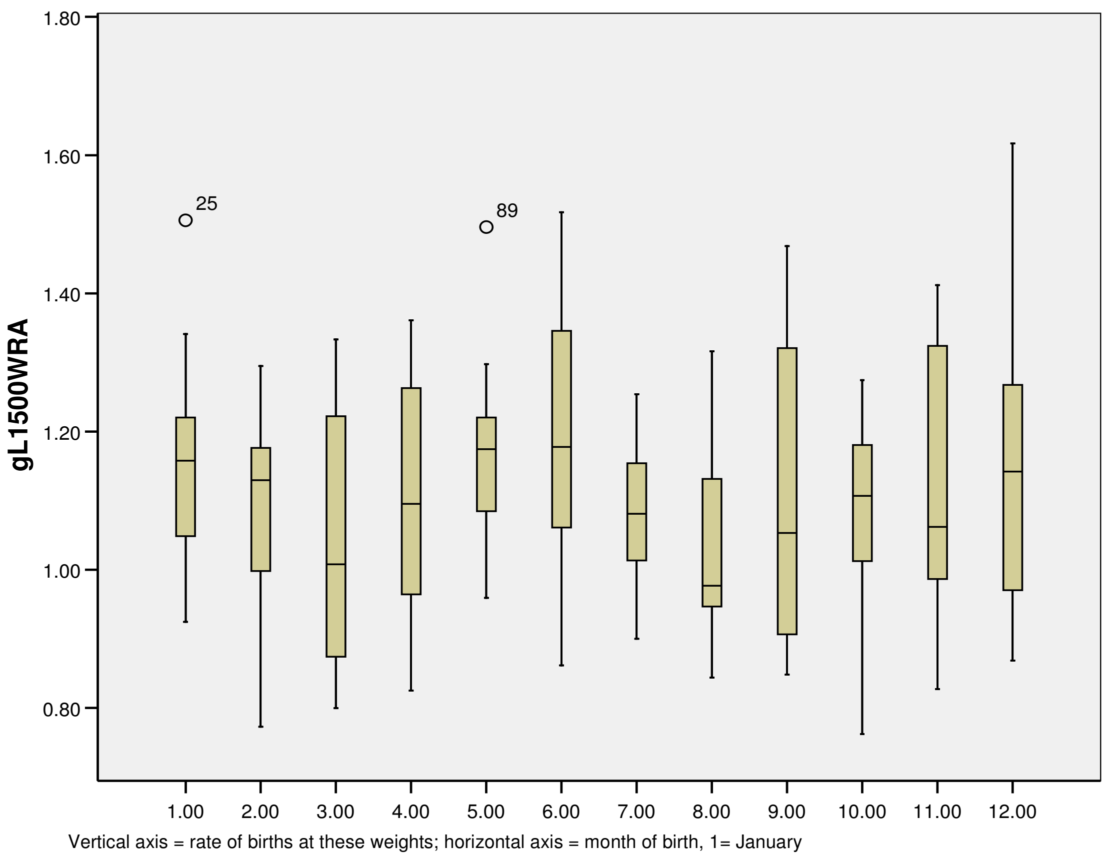


Figure B-7

Rate of White GA Births Weighing Less Than 1500g (Very Low Birth Weight): 1991-

2002

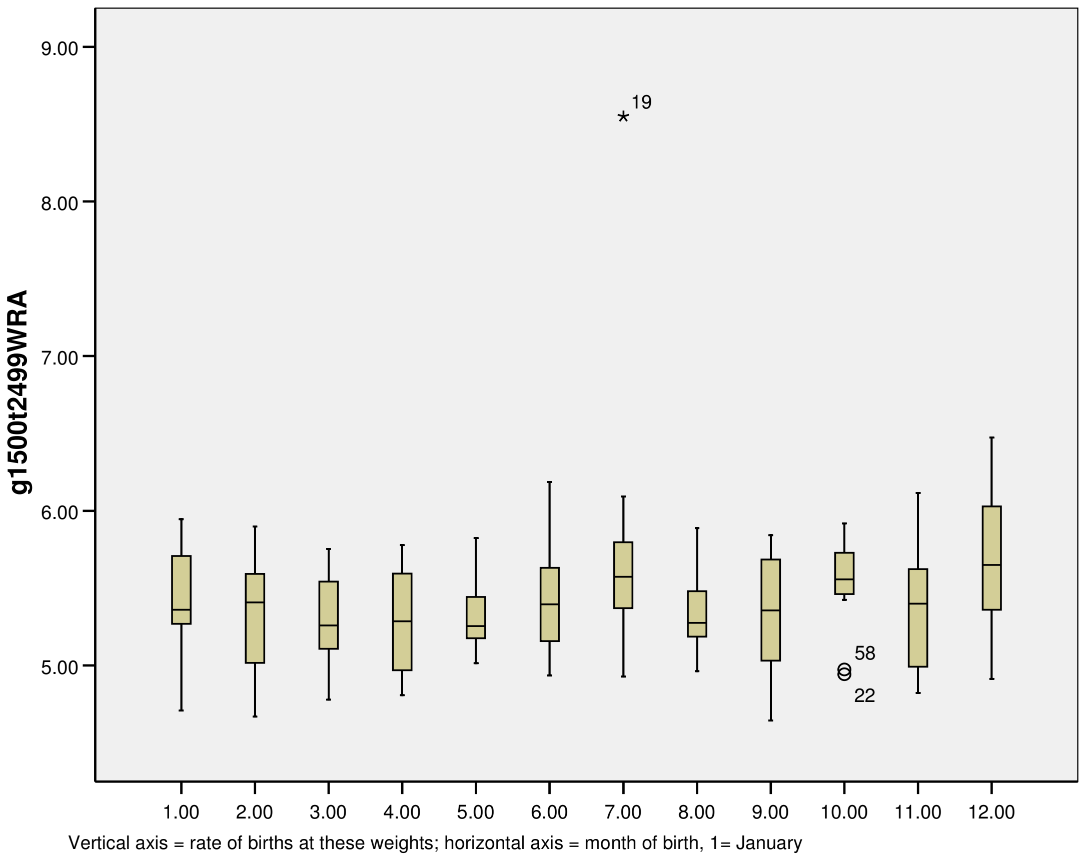


Figure B-8

Rate of White GA Births Weighing 1500-2499g (Low Birth Weight): 1991-2002

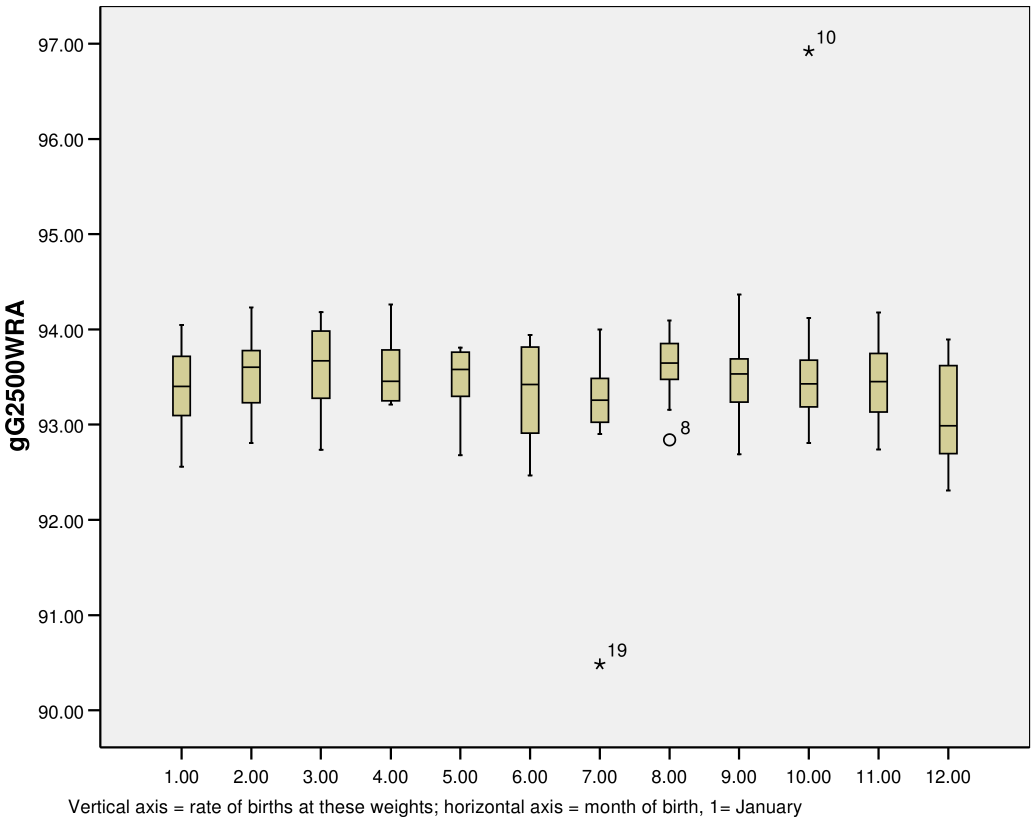


Figure B-9

Rate of White GA Births Weighing More Than 2500g (Normal-High Birth Weight): 1991-2002

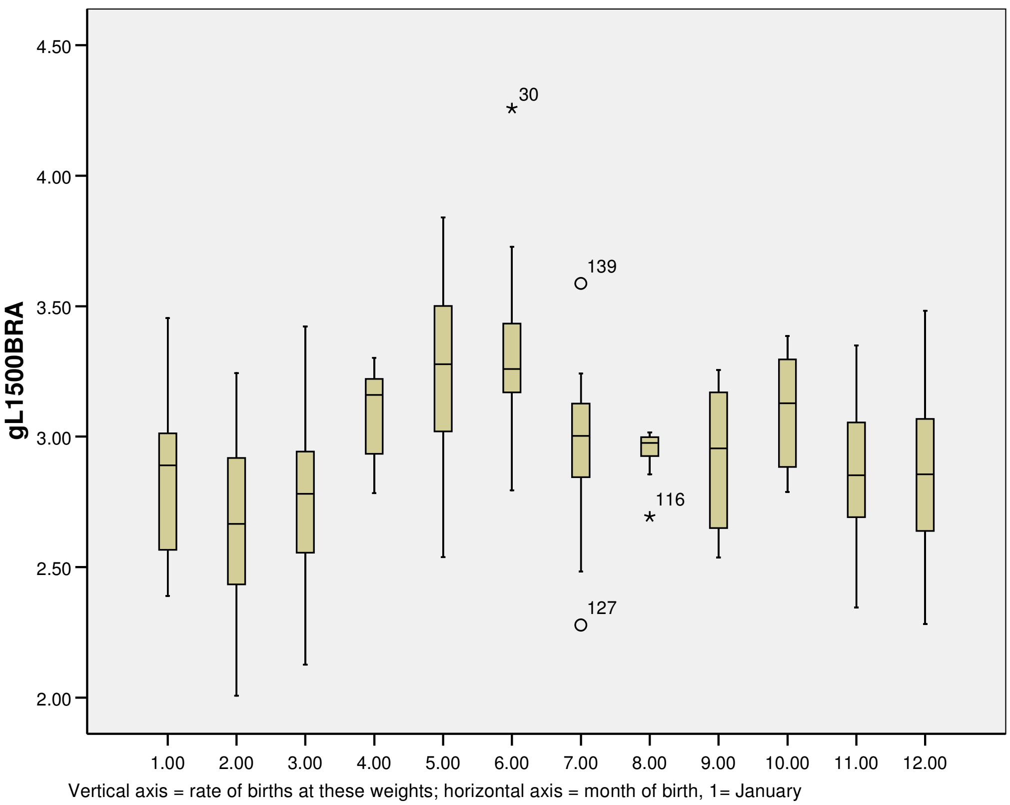


Figure B-10

Rate of Black GA Births Weighing Less Than 1500g (Very Low Birth Weight): 1991-

2002

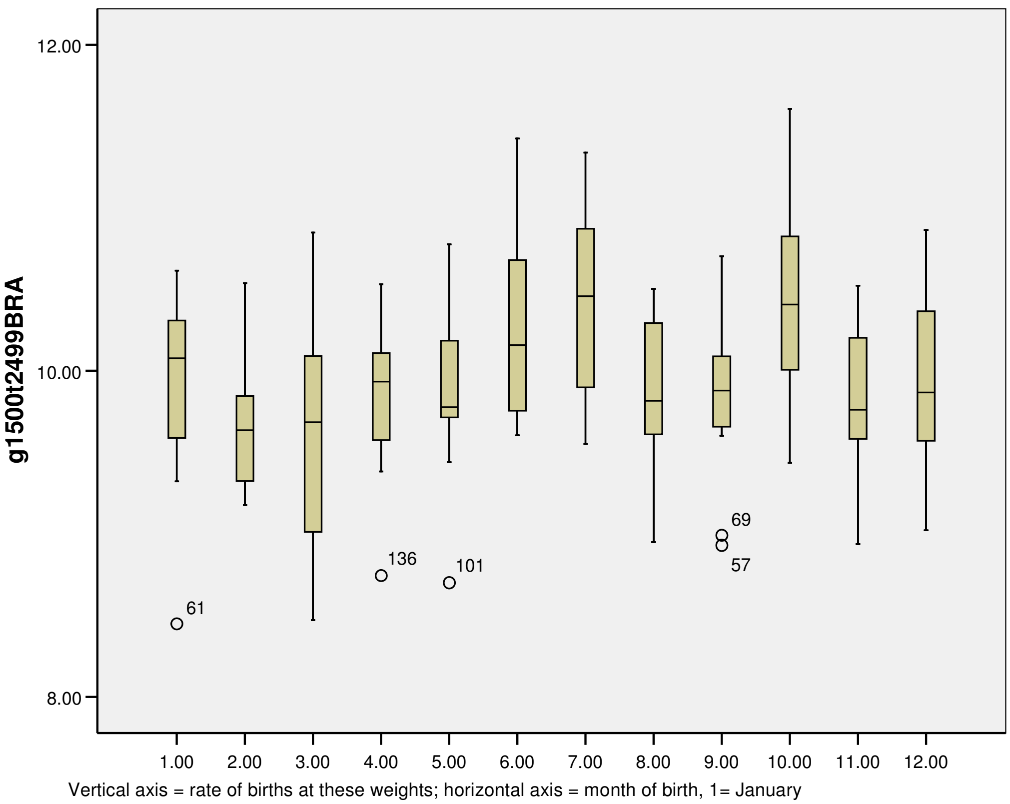


Figure B-11

Rate of Black GA Births Weighing 1500-2499g (Low Birth Weight): 1991-2002

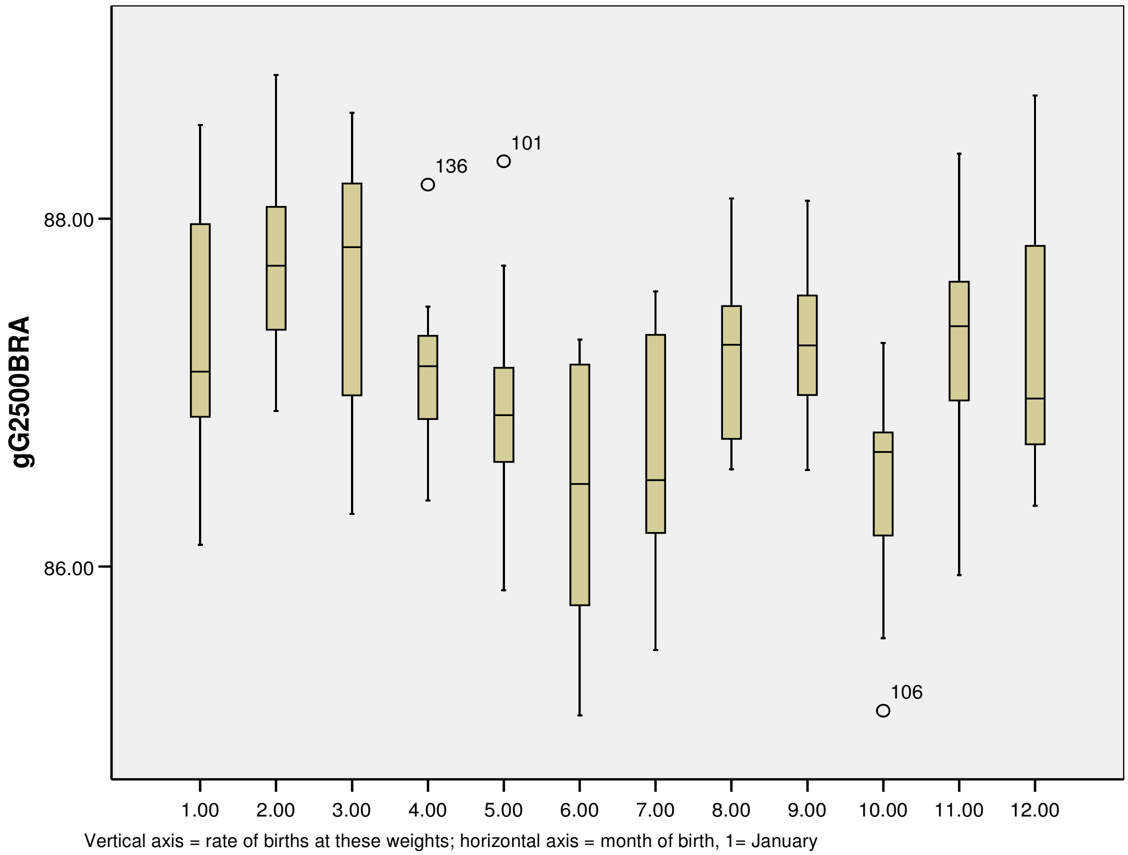


Figure B-12

Rate of Black GA Births Weighing More Than 5500g (Normal-High Birth Weight): 1991-2002

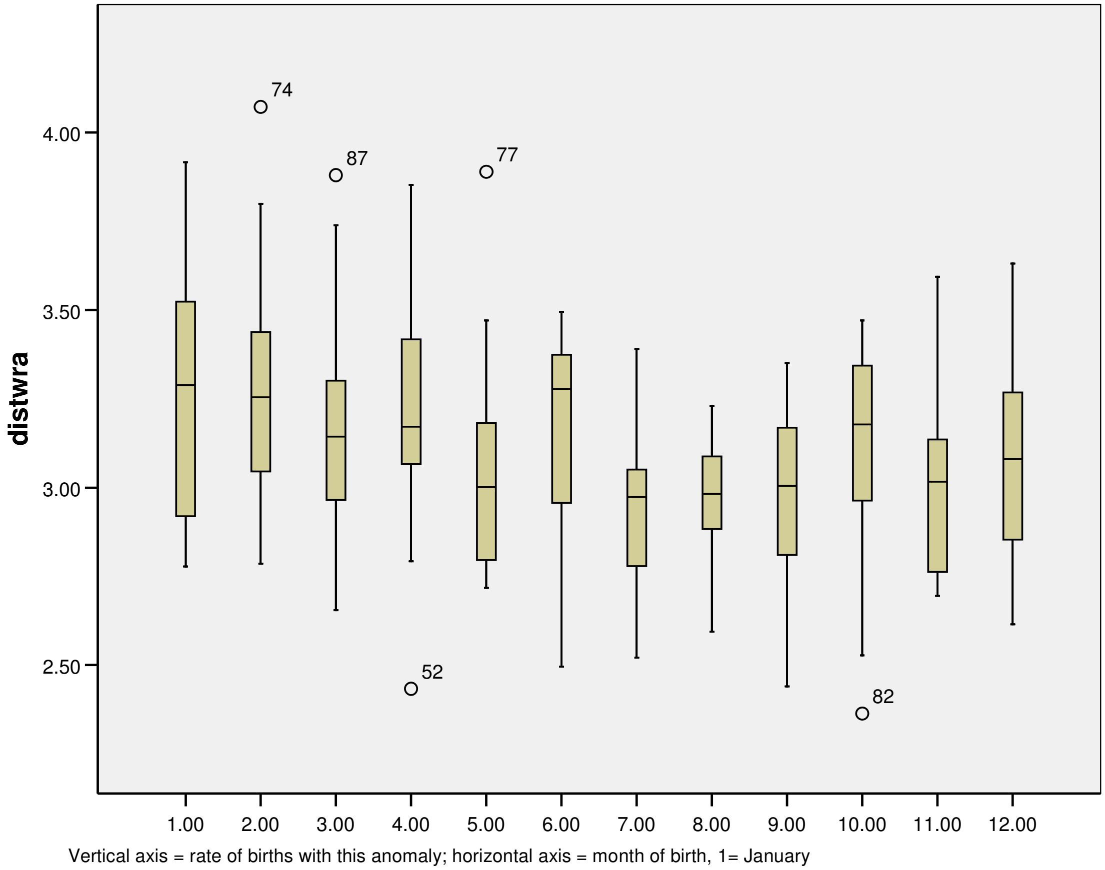


Figure B-13

Rate of White GA Births Born Experiencing Fetal Distress: 1991-2002

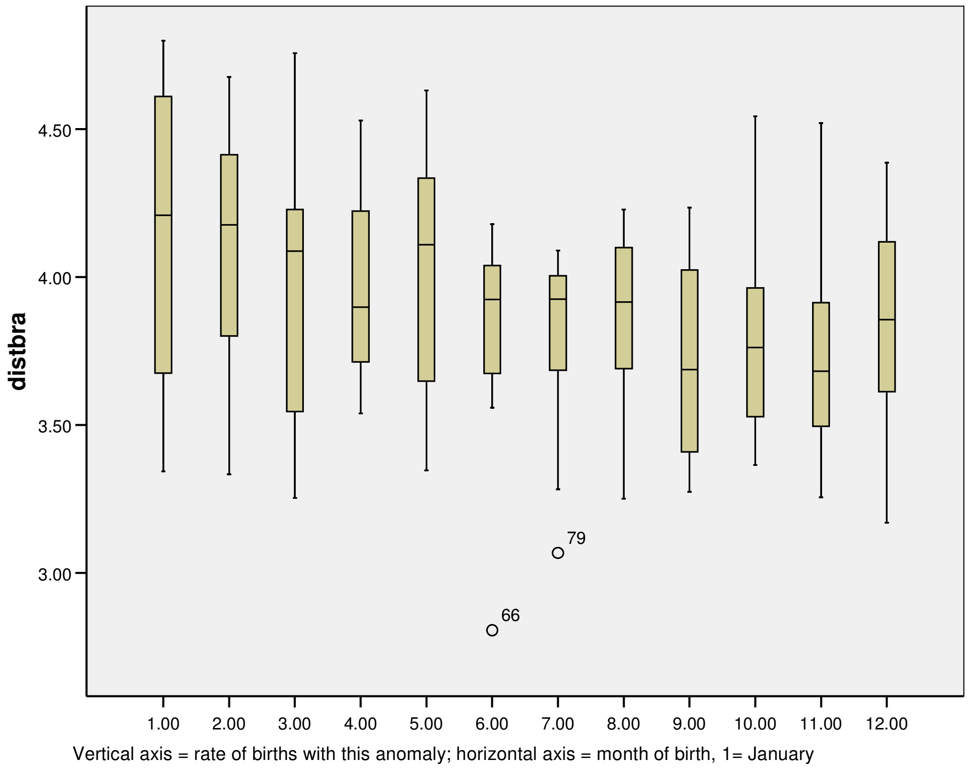


Figure B-14

Rate of Black GA Births Born Experiencing Fetal Distress: 1991-2002

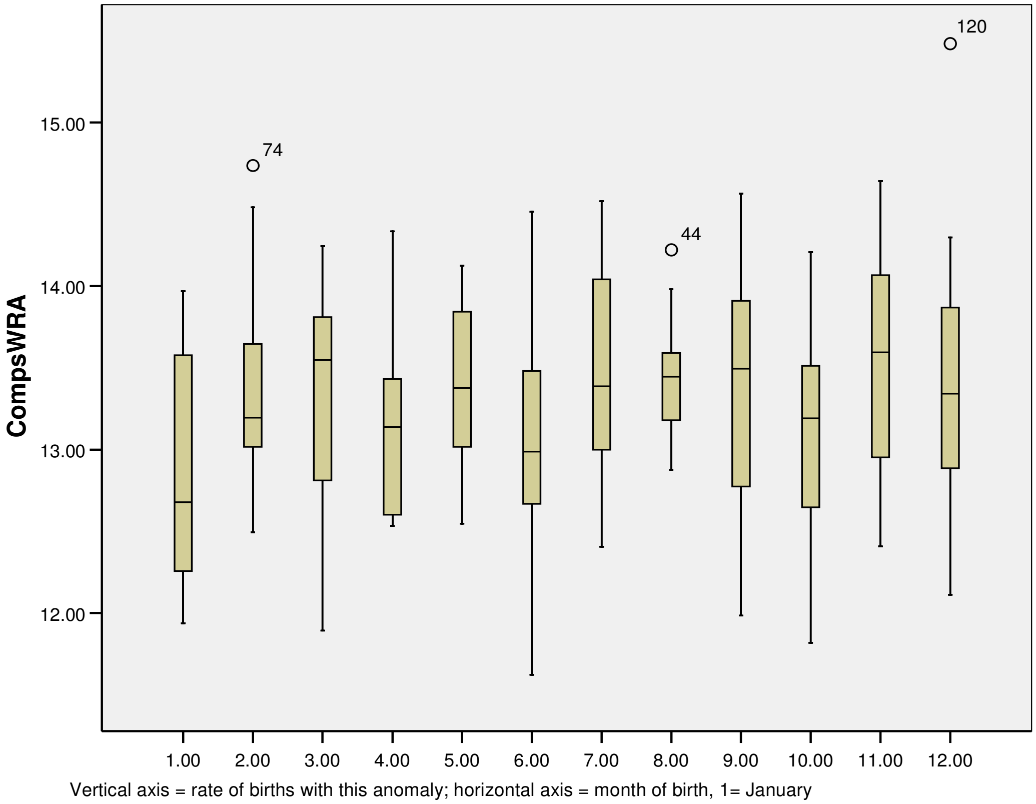


Figure B-15

Rate of White GA Births Experiencing Other Complications at Delivery: 1991-2002

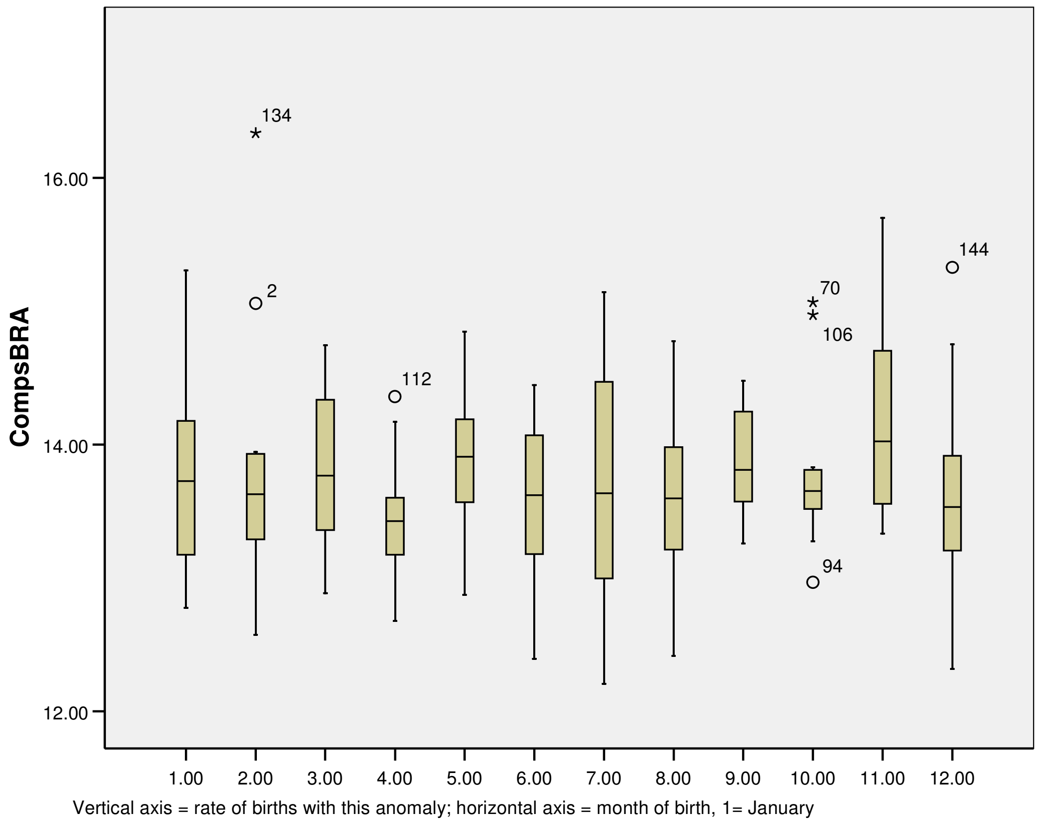
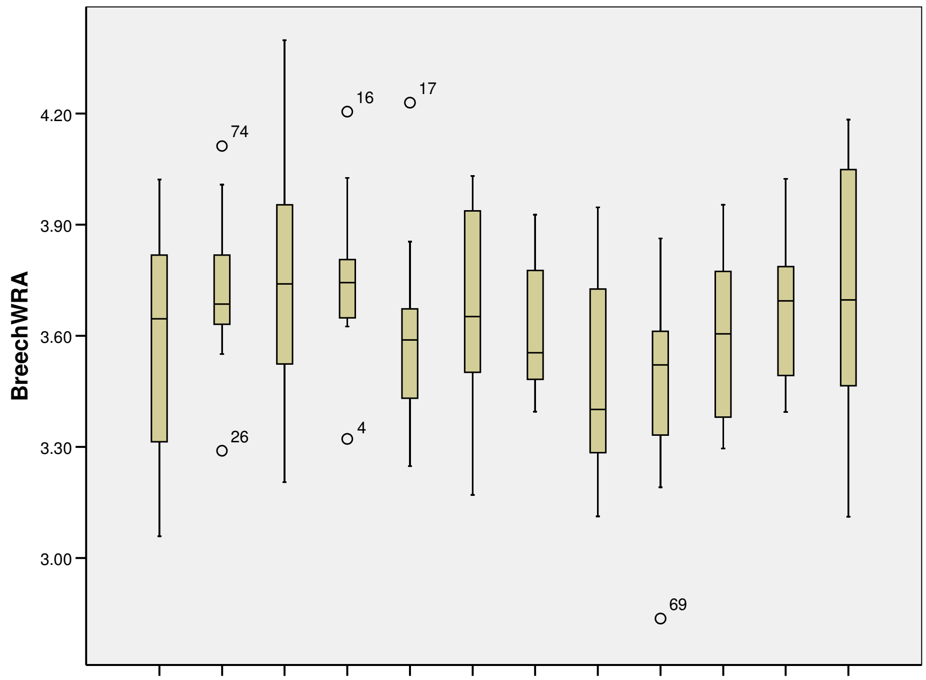


Figure B-16

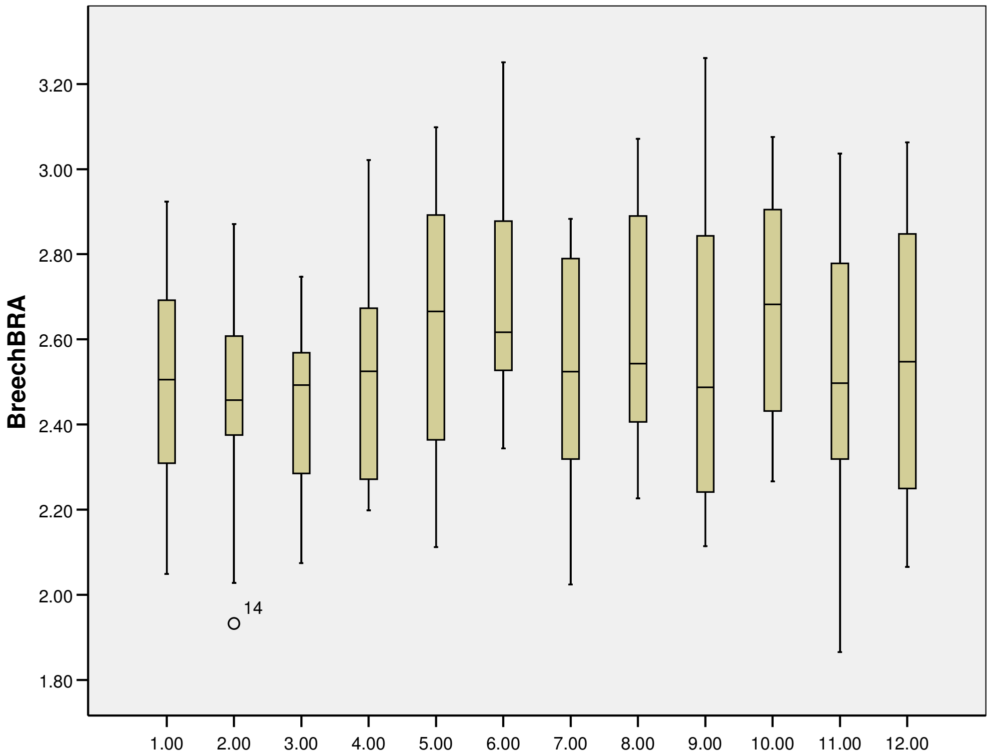
Rate of Black GA Births Experiencing Other Complications at Delivery: 1991-2002



Vertical axis = rate of births with this anomaly; horizontal axis = month of birth, 1= January

Figure B-17

Rate of White GA Births Delivered in Breech Position: 1991-2002



Vertical axis = rate of births with this anomaly; horizontal axis = month of birth, 1= January

Figure B-18

Rate of Black GA Births Delivered in Breech Position: 1991-2002

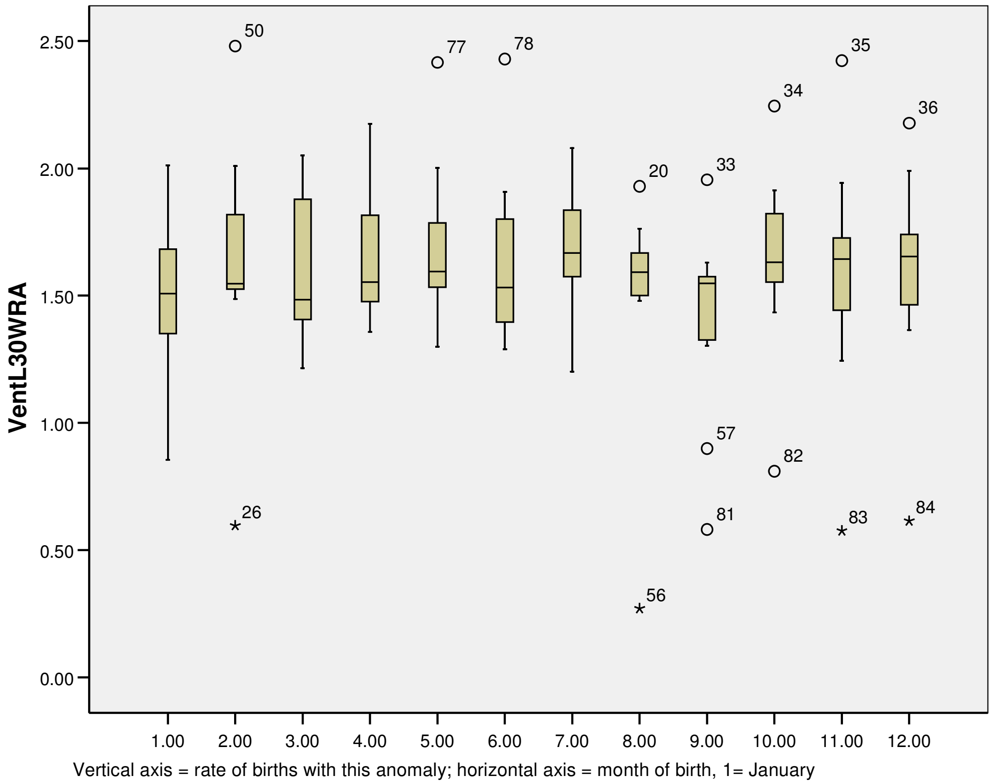
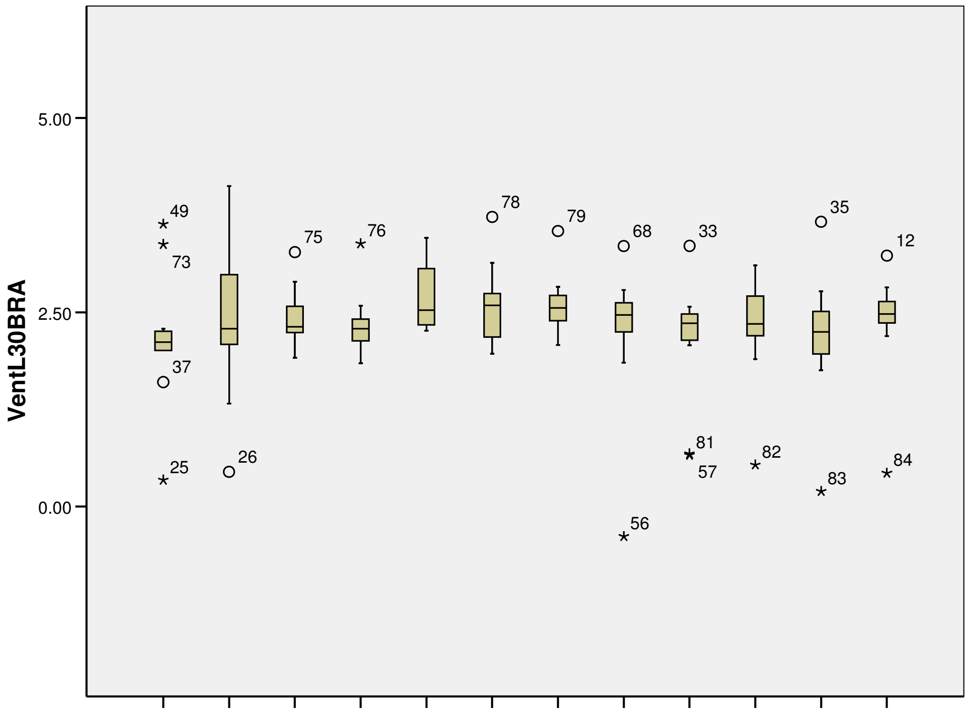


Figure B-19

Rate of White GA Births Receiving Artificial Ventilation at 30 Minutes or Less

Following Delivery: 1991-2002



Vertical axis = rate of births with this anomaly; horizontal axis = month of birth, 1= January

Figure B-20

Rate of Black GA Births Receiving Artificial Ventilation at 30 Minutes or Less Following Delivery: 1991-2002

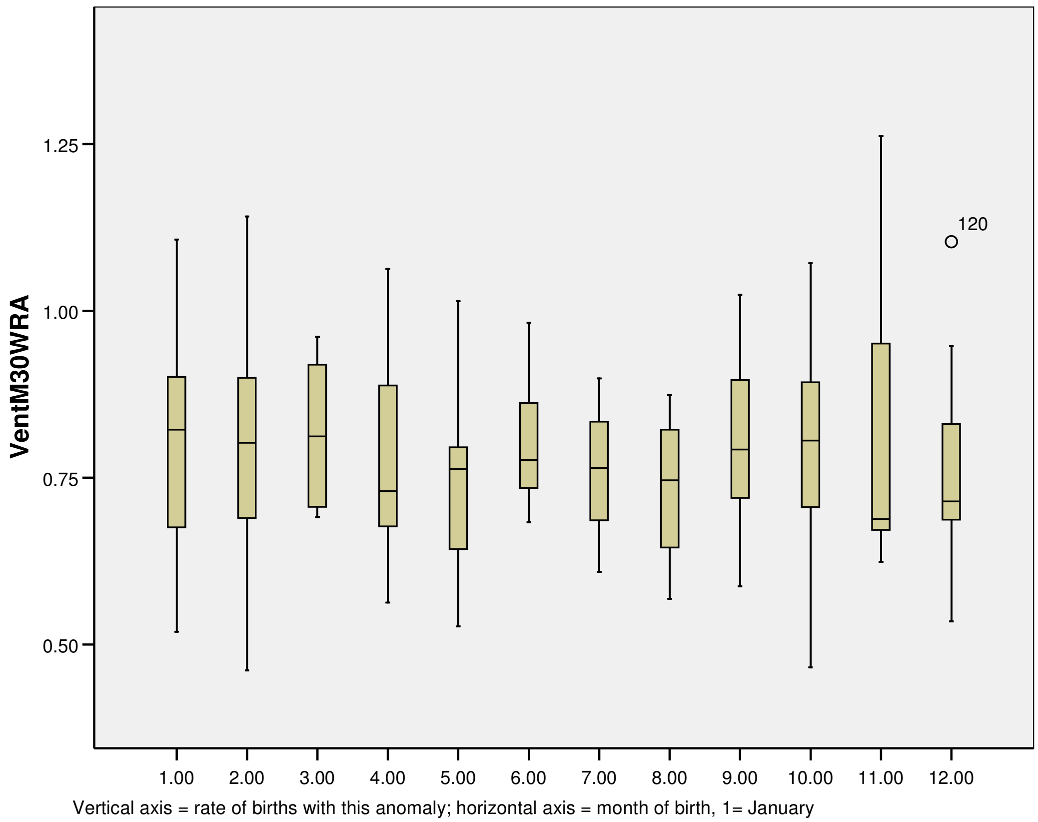
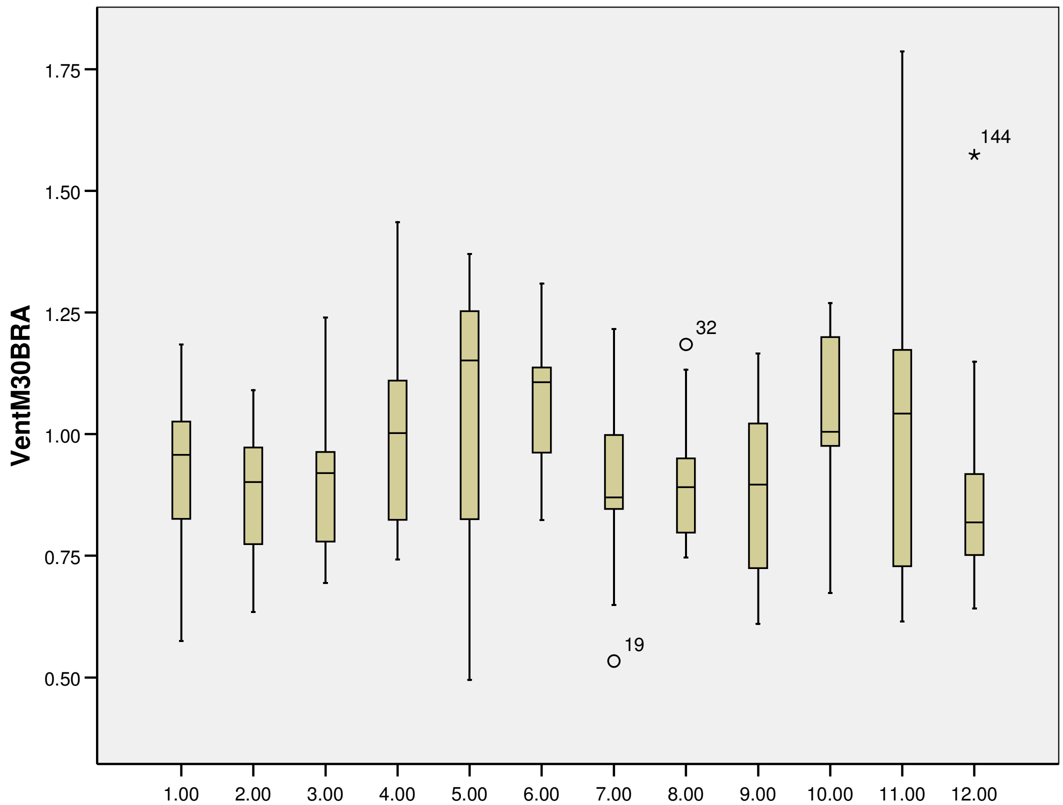


Figure B-21

Rate of White GA Births Receiving Artificial Ventilation at 30 Minutes or More

Following Delivery: 1991-2002



Vertical axis = rate of births with this anomaly; horizontal axis = month of birth, 1= January

Figure B-22

Rate of Black GA Births Receiving Artificial Ventilation at 30 Minutes or More Following Delivery: 1991-2002