Socio-Emotional and Cognitive Outcomes of Children Born Preterm and Low Birth Weight

by

Chinagorom Akwaugo Duru, RN, BSN, MS

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Approved

Wonjung Oh, Ph.D.
Chair of Committee

Mallory Boylan, Ph.D.

Yvonne Caldera, Ph.D.

Mark Sheridan
Dean of the Graduate School

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ABSTRACT

The aim of this study was to determine whether there is any significant relationship between preterm birth and birth weight on some behavioral and cognitive outcomes in children between 6 and 10 years old born in the early 2000s. It further investigates if gender moderates the relationship between preterm birth and the outcome variables. A secondary data analysis was done with the help of the "National Survey of Children's Health (NSCH) 2011-2012" dataset.

Methodologically, this study utilized a series of logistics regression analysis to examine the proposed hypotheses. Results revealed that preterm birth, but not birth weight, was significantly associated with the odds of diagnosis of depression. In addition, both preterm birth and low birth weight were significantly associated with anxiety. Both birth weight and preterm birth were also associated with the risk of ADHD. However, Autism Spectrum Disorder was not associated with either birth weight or preterm birth. As for the cognitive outcomes, the findings showed that both preterm birth and low birth weight were significantly associated with intellectual disabilities. For language deficit, both preterm birth and birth weight also showed to be significant predictors of language problem. Gender showed to interact with preterm birth to predict only language deficit but not for other outcomes. Preterm birth and low birth weight were associated with various developmental outcomes at the ages of 6-10 years. This study is important, as it will help ensure that special intervention programs be developed, or properly implemented for the at-risk group.

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CHAPTER 1

INTRODUCTION

Background of the Problem

The long-term developmental outcomes of children born with low birth weight (LBW) and/or preterm have been a focus of studies in recent years. LBW can result from various conditions including a preterm birth (delivery before 37 weeks of gestation) or can be due to what is known as intrauterine growth restriction (IUGR). IUGR refers to a condition where an unborn baby is smaller than it should be because of not growing at a normal rate inside the uterus. This means that the child was born at term, but “small for gestational age” (SGA) or "light for date" (WHO, 2014). According to the WHO, LBW describes babies who are born weighing < 2,500 g (5 pounds, 8 ounces). The infants usually are below the 10th percentile of weight by population. LBW and preterm birth mostly go hand in hand since two-thirds of infants with LBW are preterm (Russell et al., 2007).

According to the Institute of Medicine (2006), the high rate of preterm birth and LBW in the United States is an increasing public health problem. Data shows that the percentage of preterm birth has rapidly increased in the United States. The “March of Dimes Premature Birth Report Card” reported that U.S preterm birth increased from 9.6% in 2015 to 9.8% in 2016 (March of Dimes, 2016). However, LBW infants, especially those who were born with extremely low birth weight (ELBW) who would have died decades ago, are now surviving. This is as a result of the advancement in obstetric care and the management of high-risk pregnancies and infants in advanced countries, which has led to the reduction in mortality and morbidity for these children. The preterm birth rate is higher in developing countries compared to the developed countries. In low-income countries, about half of the infants born two months early die due to avoidable causes such as lack of access to intensive care and lack of available treatment materials. Contrastingly, almost all preterm infants survive in developed countries (Lawn, Mongi & Cousens, 2006).

Furthermore, preterm birth/LBW also affect every aspect of one's development, not only during childhood, but also across the lifespan (Zmyj, Witt, Weitkämper, Neumann, & Lücke, 2017). LBW and preterm birth are major causes of neonatal and infant death as well as the major contributors to childhood neurodevelopmental morbidity among survivors (Lorenz, Wooliever Jetton & Paneth, 1998). Although the survival rate of infants with ELBW is estimated to be over 50%, less than 40% of the survivors escape major neonatal morbidity (Vanhaesebrouck et al., 2004). According to the WHO, LBW resulting from IUGR affects the individual throughout life. IUGR is associated with poor growth in childhood and a higher rate of developing diseases such as Type 2 diabetes, hypertension, and heart diseases. The affected individual also experiences a higher rate of general health problems, recurrent infections, a higher rate of re-hospitalization, and poor physical growth in comparison to their peers (Hack et al., 1993). An additional risk for girls who are born with LBW is having smaller babies when they become mothers (WHO, 2014).

Statement of the Problem

Studies have shown that preterm birth and LBW not only affects children's motor development during early childhood (Jeyaseelan et al., 2006); they also affect intellectual development that can persist into adulthood (Lohaugen et al., 2010). Other studies have demonstrated that cognitive deficits, academic underachievement, and behavioral problems are prevalent in school-age children who are born extremely preterm or with ELBW compared to those born at term or normal weight (Anderson and Doyle, 2003; Marlow, Walke, Bracewell and Samara, 2005, Shah, Kaciroti, Richards, Oh & Lumeng, 2016). Undoubtedly, many children who were born with LBW or preterm eventually catch up to their peers, whereas others do not. As a result, a child born with LBW/preterm who is developing appropriately for his age during infancy may later develop a range of problems in areas that emerge during childhood. Certain disorders such as Attention Deficit Hyperactivity Disorder (ADHD), ASD, and depressive disorder are diagnosed overdevelopment, and become more prevalent during middle childhood. According to a study, more than half of school-age children diagnosed with ADHD and ASD were at 5 years and older when they were first diagnosed (Hertz-Picciotto & Delwiche, 2009).

Therefore, age at assessment is very important in understanding the effects of LBW, preterm birth and other sociodemographic variables on both cognitive and behavioral outcomes. Research is required to understand the long-term outcome for these children, especially during school years. This is why the focus of this study is on children between 6 –10 years old because this is the period where the cognitive and behavioral problems of interest are first noticed and diagnosed.

Purpose of the Study

A growing body of evidence suggests that early-intervention programs may enhance the development of fragile infants (Spittle, Anderson, Lee, et al., 2010).

Socioeconomic and other demographic factors may play a significant role in the developmental outcome of these children. Thus, there is need to understand the effects not only birth weight and preterm birth have on the cognitive and behavioral outcomes, but also the effects of other sociodemographic variables such as race, gender, parents' education, poverty, and home environment/living condition on the outcomes variables.

Thus, the aim of this study was therefore to investigate the relationship between LBW and preterm birth on the cognitive and behavioral outcomes of school-age children (6 – 10 years) in the USA. Second, the present study sought to understand the impact of sociodemographic variables on the development of these outcomes. Finally, this study also aims to investigate the moderating effects of gender and preterm birth on the outcome variables.

Significance of the Study

Although early childhood outcome may not necessarily predict long-term consequences for some children (Johnson, 2007), for others, the outcomes of LBW and preterm births persist for a long time. While the cognitive and behavioral outcomes of LBW infants and preterm children have been studied, many of previous studies suffer from one or more methodological problems such as the use of smaller sample size, and data collection method that is often limited to a specific region (such as children born at one specific hospital/region). It is important to understand the underlying factors responsible for why some LBW and preterm children develop without any deficit whereas others develop some deficits. In addition, most of these studies based the risk of developing the outcome variables on the screening instrument rather than on a diagnosis by a healthcare professional.

Hence, the significance of this present study is to fill in these gaps from previous research. To address the gap in knowledge, this present study is interested in using a nationally representative, population-based sample to understand the relationship between the predictor variables and the outcome variables. Another importance of this study is that the outcome variables are based on a report of a diagnosis by a doctor or other healthcare professionals. This way, children who are at risk can be identified for close observation and early intervention, so they can reach their full potentials.

CHAPTER II
REVIEW OF LITERATURE

This chapter will address the theoretical framework of this study, and then continue to review the existing literature that examined effects of preterm birth and LBW on depression, anxiety, ADHD, ASD, intellectual disabilities and language problems. Finally, the goal of this study will be highlighted as they emerge from the gaps identified in the current literature.

Theoretical Framework

The current study utilized the Life Course Theory (LCT) proposed by Elder (1998). The LCT recognizes the important relationship between the mental, physical and social health of individuals. This theory integrates both lifespan and life stage concepts that determine the individual's outcome. LCT has been defined as the study of "long-term effects on a later health of physical or social exposures during pregnancy, childhood, adolescence, young adulthood, and later adult life" (Kuh, Ben-Shlomo, Lynch, Hallqvist & Power, 2003. P. 778). LCT explores how physical, psychosocial and behavioral processes from birth to old age act additively and interactively to influence an individual's development (Nosarti, Murray & Hack, 2010). In this theoretical approach, individuals' life courses are investigated in their biocultural and sociohistorical context.

Thus, the early physical health problems experienced early in life such as preterm birth and LBW, the home environment in which the child is exposed, and the relative socioeconomic disadvantage experienced early can affect one's cognitive and emotional development later in life. According to LCT, five distinct principles exist to describe how early exposures influence later outcomes. The principles include: (1) sociohistorical time and geographical space (2) lifespan development (3) timing of the event (4) agency and (5) linked lives (Black, Holditch-Davis & Miles, 2009). We used these principles to understand how LBW, preterm birth and certain socio-demographic variables such as gender and ethnicity can affect certain areas of children's development.

The principle of sociohistorical time and geographical space stipulate that human lives are shaped by questions such as when and where? in a sociohistorical sense (Black et al., 2009). Historical forces shape the life course of an individual, the psychological and social path of family, education, and relationships, and they, in turn, influence the behavior of other aspects of development. The significance of this principle can be clarified by comparing the role technology and economic advancement play in the survival of LBW infants, and how these can influence behavioral and cognitive outcomes in the individuals. During childhood, certain things such as birth weight, preterm birth, and ethnicity, gender, parents' education, and living condition are likely to play important roles in one's survival and development. Social and economic factors can impede access to technology and other interventions that would have ensured that at-risk children received the best care as infants. Conditions such as poverty or lack of access to hospitals can greatly affect not only the survival of children with LBW/preterm but may also have long-term consequences such as the socio-emotional development which can affect their relationship with peers.

The second principle of LCT is lifespan development. This focuses on how individuals develop in every aspect beyond childhood (Elder et al., 2003). Whatever a child experiences during infancy can affect the child during school-age years. Therefore, birth weight, preterm birth, and sociodemographic variables can significantly affect later outcomes in certain developmental domains such as emotional, behavioral, speech and learning abilities (Elder, 2003).

The principle of the timing of life events is also crucial in an individual's development. This principle refers to the chronological ordering of events. It explains that the developmental impact of an event is subject to when they occur in a person's life, whether the event occurred prenatally or at birth. Different exposures occur at different times across the life course, with each exerting an independent additive effect (Kingston, 2009). When an individual is born with LBW, it has the power to affect the individual during childhood. Although life events cannot be rigidly predetermined, certain biological events can be ordered chronologically such that if they are experienced out of order, it will result in both physical and social consequences (Black et al., 2009). For instance, childbirth is supposed to happen at a specific time, but when the child is born before term, this may result in long term problems.

Agency, the third principle of the LCT was based on the premise that people are not passive receivers of a programmed life course, rather, they make choices that shape their lives (Hitlin & Elder, 2007). This means that human beings have the capacity to make specific choices, but this depends on opportunities and constraints. This concept is particularly important in the context of family/home environment. Due to no fault of their own, individuals who have witnessed parental death or whose parents have been to jail may exhibit certain characteristics that can have a detrimental effect on their behavior such as being withdrawn, having depression and other social problems as a result of their experiences at home.

Finally, linked lives mean that lives are lived "interdependently reflecting sociohistorical influences" (Marshall & Mueller, 2003). This perspective refers to other social relationships that are beyond family ties such as friends, schools, and neighborhoods. These social relationships help shape how the individual interprets life events. People differ in how they integrate social norms and relationships. However, this integration may be interrupted under certain circumstances (Black et al., 2009). In this study, we will test for the effect of some events and how they affect the growing child.

The Incidence of Low Birth Weight and Preterm Birth

The World Health Organizations classified LBW into three categories: extremely low birth weight (ELBW), very low birth weight (VLBW) and moderate low birth weight (MLBW). ELBW are group babies born weighing <1000 g (2 pounds 3 ounces), the VLBW group are born weighing <1500 g (3 pounds 5 ounces), MLBW is a weight of <2500 g, while normal weight is 2500–4200 g (5 pounds 8 ounces – 9 pounds 4 ounces) irrespective of the gestational age. WHO also classified preterm birth into three categories: extremely preterm (<28weeks), very preterm (28 to <32weeks), and moderate to late preterm (32 to <37weeks). This birthweight classification is based on the observation that infants born below 2500g are approximately 20 times more likely to die than those born above 2500g. In human beings, birth weight commonly correlates to gestational age. The above weight-based classification of newborns is based on the understanding that VLBW and ELBW neonates are often born preterm (Yang et al., 2015). Therefore, preterm and LBW are sometimes used interchangeably in this literature review.

Besides, the survival of a preterm infant depends on the gestational age as well as the birth weight, as the survival rate is greater with increasing gestational age. Research shows that for a preterm infant born at 32 weeks gestation, the outcome is similar to a term infant with a survival rate of about 97%. Survival rate further decreases for infants born before 28 weeks gestation, with a survival rate of 78%. The prognosis for infants born before 24 weeks is poor, with a survival rate of just 31% (Larroque et al., 2004). According to the March of Dimes (2015) report, the rate of preterm birth in the United States is increasing, and that the US rate is higher than most developed countries, with 1 in 10 infants being born preterm in the United States. Nevertheless, there are disparities in the rate of preterm births among different ethnic and racial groups in the United States. The highest rate of preterm birth is found among African-American women, whereas Asian or Pacific Islander women have the lowest rates of preterm birth (IOM, 2006).

Also, reports have shown that preterm birth is the leading cause of death among infants. According to these reports, LBW infants and preterm infants are biologically more susceptible to health challenges compared to the normal weight and term infants. Because birth weight below the cut-off point contributes to a wide range of poor health outcomes (WHO, 2014), the rate of respiratory distress, apnea, feeding difficulties, seizures, jaundice, and re-hospitalizations are highest among infants born extremely preterm (Escobar, et al., 2006). These infants are also at increased risk of acquiring hospital infections as a result of frequent exposure to multiple invasive procedures following their birth. They also have considerably higher rates of congenital anomalies with rates fourfold higher than infants delivered at term (Linhart et al., 2000). According to research, the outcome is greatest during the early years of the child's life and declines with age, although the impact continues into adolescence and adulthood (Zwicker & Harris, 2008). Although improvements in medical care have significantly improved their survival rates, infants born with LBW or preterm are at a higher risk of developing a wide range of neurodevelopmental problems (Xiong, Gonzalez, & Mu, 2012). For example, in their meta-analysis of risk factors for neurodevelopmental outcomes, Xiong and his colleagues (2012) found that early gestational age and LBW are the major predictors of poor neurological outcomes in the long term.

Again, not only does preterm birth affect the infant alone, it also affects the family. The birth of a preterm infant can have a negative emotional and psychosocial effect on the family. According to Taylor, Klein, Minich, and Hack (2001), psychological stress is greatest during the first month through the first two years of life. This is because the birth of a preterm/LBW infant puts enormous stress on the parents. (Davis, Edwards, Mohay, & Wollin, 2003). It has been found that the mothers of preterm infants have often scored higher on the Edinburgh post-partum depressive symptoms questionnaire compared to mothers of full-term infants (Davis et al., 2003).

In addition, the effect of preterm birth can continue into adulthood. A longitudinal study by Moster, Lie, and Markestad (2008) showed that when preterm infants were followed into adulthood, those who achieved higher education, held well-paying jobs, and did not receive social security benefits were fewer than those born at term.

Risk Factors of Low Birth Weight and Preterm Birth

Several factors affect the duration of pregnancy and fetal growth. These factors can either be related to the fetus, the mother, or the environment. Recognizing the risk factors for preterm birth and LBW is vital because it helps in the commencement of risk-specific treatment early in life (Goldenberg, Goepfert & Ramsey, 2005).

For the fetal risk factors, the use of assisted reproductive techniques (ART) has been shown to be a risk factor for LBW because ART increases the risk of higher order pregnancies. Higher order pregnancy is a pregnancy in which the woman carries three or more fetuses at the same time. ART is linked with an increased number of adverse effects, particularly preterm birth, multiple births, LBW, VLBW, and increased risk for short and long-term disabilities (Garite, Clark, Elliot & Thorp, 2004). Schieve and his colleagues (2002) found that ART singletons were 2.6 times more likely to be term-LBW compared with the general population. In addition, Ericson and Källén (2001) supported that ART had a threefold risk for some specific birth defects. Another fetal cause is the gender of the fetus and the birth position. According to WHO (2016), girls typically weigh less than boys do, and first-born children are usually lighter than the subsequent infants. Therefore, it is important to test the moderating effects of gender on both cognitive and socio-emotional outcomes in this study.

On the other hand, a previous history of preterm birth and low socio-economic status of the mother are other predictors of preterm birth and LBW. Women in disadvantaged socio-economic conditions often have LBW infants (WHO, 2014). This stems from the mother's poor dietary intake and poor health over a long period of time. Poor health and nutrition prior to and during pregnancy result in the prevalence of infections or complications, and coupled with the physical demands of pregnancy can result in fetal growth restriction and subsequent LBW. Another factor to preterm birth is teenage pregnancy. This is generally due to socioeconomic factors as low SES may result in lack of antenatal care or late attendance to antenatal care. Low SES may also lead to other risky behaviors such as smoking which can affect the fetus (Lawlor, Mortensen, & Andersen, 2011).

Furthermore, the incidence of LBW is heightened among single mothers who do not have social support and those who do not make a good emotional adjustment to pregnancy. These women may try to induce preterm births (Goldenberg et al., 2008). Women who are pregnant for the first time have a higher chance of having a preterm infant compared to subsequent pregnancies (Ahern, Pickett, Selvin, & Abrams, 2003). Another important risk factor for LBW and preterm birth is increasing maternal age. Studies have shown that the number of new mothers in the United States who are above 35 years of age has increased from about 9% in 1980 to about 25% in 2004 (Luke & Brown, 2007). This figure may even be higher in recent years. The relationship between maternal age, preterm birth and LBW may not be due to age per se, but may be because of other medical conditions that occur with increasing maternal age such as diabetes and hypertension. High blood pressure during pregnancy may result in IUGR, with consequent LBW. This is because allowing the pregnancy to advance despite the growth restriction can endanger the life of both the mother and the child. This condition can prompt the medical personnel to deliver the infant despite not reaching full term or normal weight (Roberts, Pearson, Cutler, & Lindheimer, 2003). Delivering the baby early may result in the birth of an infant who is preterm with LBW.

Similarly, the maternal weight may also affect infant's birthweight. A mother's own fetal growth and her diet from the time of her birth to pregnancy and delivery affect her child's weight (WHO, 2014). Low maternal body mass index (BMI) is associated with neonatal LBW. Evidence has shown that women with BMI of <19kg/m² had a preterm birth rate of 17%. Mothers with a BMI between 19-24.9kg/m² had a rate of approximately 11%, whereas those with a BMI of 25-29.9kg/m² and 30-34.9kg/m² had a rate of approximately 8% and 7% respectively. The lowest rate of LBW was found in obese women with BMI over 35kg/m² with a rate of only 5% (Hendler et al., 2005).

Finally, environmental influences can also affect prenatal outcome. A study by Bobak (2000) conducted to test the association between air pollution, LBW, and preterm birth found that preterm birth/LBW were linked with maternal exposure to air pollutants such as sulfates, especially during the first trimester of pregnancy. Other factors such as alcohol, tobacco or drug abuse can also result in the birth of children with LBW. According to Goldenberg, Culhane, Lams and Romero (2008), other maternal and fetal characteristics associated with preterm birth include maternal nutritional status, pregnancy history including biological and genetic markers, lack of prenatal care, infection, stress, uterine overdistention, maternal stature, and geography, as those who live in high altitudes have been shown to have smaller babies.

Preterm Birth, Low Birth Weight, and Socio-Emotional Outcomes

Children born preterm with LBW are also at risk of exhibiting a wide range of behavioral problems. The consistent findings in the pattern of behavioral problems identified in preterm children have led to the suggestion that there is a "preterm behavioral phenotype”. According to the authors, this pattern of behavior is characterized by “inattention, anxiety and social problems" (Yang et al., 2015. P. 359).

To evaluate later behavioral outcomes for children at age 11 who are in middle school, Taylor and his colleagues compared a sample of three groups of children. The first group (N = 60) were <750g birthweight, the second group was made up of 55 children with birthweight 750 – 1,499 g and the third group were 49 children born at term as the control group. The groups were matched in terms of age, gender, and demographic variables at the time of assessment. The study showed that the <750g birthweight group performed less well at middle school-age in comparison to their term counterparts on measures of cognitive function, academic performance, and behavior.

In addition, the above study also found that about 37% of those that weighed <750 g exhibited significantly more behavioral problems according to teachers’ and parental reports. For those that weighed between 750-1499 g and the term groups, about 21 % exhibited some behavioral problems. The two major behaviors of concern include poor attention and hyperactivity. By middle school-age, parental concern about behavioral problems had declined slightly in the <750 g group, but about 23% were still exhibiting clinically significant behavioral problems. When compared with the 750-1499 g group and the term group, the <750 g group was still over than four times more likely to have behavioral problems compared to the term group. The result also showed that the <750 g group reported lower self-esteem especially in areas of self-acceptance, academic ability, and athletic ability. Although this group difference was not statistically significant (Taylor et al., 2000).

In another study to evaluate the rates and predictors of psychiatric disorders at age 7 in children born very preterm, Treyvaud and his colleagues (2013) investigated 177 very preterms and 65 term born children. The very preterm group were born at <30 weeks' gestation or with a birth weight <1250 g. Data was collected from the perinatal medical data and included brain abnormalities detected using MRI. The children were administered the Infant-Toddler Social-Emotional Assessment (ITSEA) and Strengths and Difficulties Questionnaire (SDQ) at 2 and 5 years respectively. At the age of 7, they were also administered the Developmental and Well-Being Assessment (DAWBA). This was used to designate psychiatric diagnoses. Data analysis showed that when compared with term-born children, very preterm children had three times the chances of meeting criteria for any psychiatric diagnosis by the age of age.

The above authors found that the most common diagnoses were anxiety disorders, ADHD, and ASD. The very preterm group had about 11% diagnosis of anxiety disorder while it was 8% in the term group. For ADHD, the rate was 10% in the very preterm group whereas it was 3% in the term group. For ASD, the outcome was 4.5% in the very preterm group, and 0% in the term group. The analysis also showed that for children born very preterm, those with severe global brain abnormalities, those with social-emotional problems at 5 years of age, and those who have a higher social risk by the age of 7 were at a greater risk of meeting the criteria for a psychiatric illness by age 7. When gender was added to the model, the analysis showed that females born very preterm were more likely to meet the criteria for the diagnosis of psychiatric illness than males, however, the relationship was weak. The authors suggested that although social-emotional problems at age 5 were a strong predictor of later psychiatric outcomes, waiting until the age of 5 years to identify children at risk is a long time, and the opportunity for prevention and earlier intervention might be missed (Treyvaud etal., 2013).

Preterm Birth, Low Birth Weight, and Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is the most common neurodevelopmental condition in western countries. It has a prevalence rate of about 3-5% (Rowland, Lesesne & Abramowitz, 2002). Birth status such as LBW and preterm birth have been shown to be associated with increased diagnosis of ADHD in schoolchildren. This means that the lower the birth rate or the lower the gestational age, the higher the risk of developing ADHD. Some studies have found that children born at about 23-25 weeks of gestation are 3-4 times more likely to be diagnosed with attention problems in comparison to their full-term peers (Farooqi, Hägglöf, Sedin, Gothefors, & Serenius, 2007).

Farooqi et al. investigated a national cohort of children born extremely preterm with respect to behavioral, emotional, and social competencies. They collected the data from the perspectives of the parents, the teachers, and the children themselves. The study examined 11-year-old Swedish children who were born preterm (before 26 completed weeks of gestation) between 1990 and 1992. The sample included 89 preterm children who were compared with an equal number of control subjects. They matched the groups based on age and gender. They also assessed the behavioral, emotional, social competencies, and adaptive functioning at school using a standardized, well-validated instrument. The instrument includes parent and teacher report questionnaires as well as a child self-report. From the analysis, it was found that parents of children born extremely reported significantly more problems with internalizing behaviors (such as anxiety, depression, withdrawn, and somatic problems). Parents of extremely preterm children also reported more attention, thought, and social problems compared with control subjects. Teachers also reported a similar pattern of outcomes as parents. Reports from children showed a trend toward increased depression symptoms for preterm group compared to the control group, although the children were more likely to rate themselves lower compared to the parents (Farooqi et al., 2007).

In addition, Lindstrom, Lindbla, and Hjern (2011) conducted a study to understand the effect of moderate and extreme preterm birth on the risk of ADHD in school-age children while taking into consideration the genetic, environmental and perinatal risk factors. The sample comprised of Swedish children born from 1987 to 2000. More than one million children (precisely 1,180,616) were included in the study and were followed up for ADHD medication at the age of 6 to 19 years. 7,506 children in the sample population were using ADHD medication. The gestational age was categorized into extremely preterm (23-28 weeks), very preterm (29-32 weeks), moderately preterm (33-36 weeks) and term group. The moderate group was subdivided into 33-34 weeks and 35-36 weeks while the term group was subdivided into 37- 38 weeks and 39-41 weeks.

The study found that there is a link between preterm birth and ADHD, even after accounting for genetic, perinatal and socioeconomic confounders. The logistic regression analysis showed a “stepwise increase in the odds ratio for ADHD medication with increasing degree of immaturity” (p.858). When adjusted for age, gender and county of residence, the odds ratios for ADHD medication were 2.5 for 23 - 28 weeks’ gestation, 1.9 for 29 - 32 weeks, 1.6 for 33 - 34 weeks, 1.4 for 35 - 36 weeks and 1.2 for 37 - 38 weeks' group compared with those born at term (39 – 41 weeks). In the fully adjusted model, the odds ratio slightly decreased to about 2.1 for the 23 - 28 weeks' group, 1.6 for 29 - 32 weeks, 1.4 for 33 - 34 weeks, 1.3 for 35 - 36 weeks, and 1.1 for 37 - 38 weeks in comparison with term children born at 39-41 weeks.

Again, being born small for gestational age for children born at term increased the odds ratio for ADHD medication by 1.4 even after adjusting for sociodemographic variables. Surprisingly, maternal education increased the effect in moderately preterm births, but not for the extremely preterm group on the risk for ADHD. Although this study focused on the moderate and the extremely preterm birth, it has been understood that preterm birth and LBW go hand-in-hand as children born very preterm and extremely preterm are most likely to be LBW (Russell et al., 2007). However, the effects of gestational age on ADHD were similar for both boys and girls. The authors concluded by reinforcing that the association between preterm and LBW to ADHD is graded by degree of preterm birth/LBW. This conclusion means that children with the lowest birth weight and those born with increasing prematurity have the highest risk of ADHD.

Another study carried out in Southern Taiwan to investigate the emotional, behavioral symptoms, psychiatric diagnoses as well as the functional status in a cohort of VLBW adolescents between the age of 12-15, found a link between birth weight and the above outcomes (Yang et al., 2015). The study was conducted using a sample of 61 children with an average birth weight of 1,208 g. Parents completed the Chinese Version of the Child Behavior Checklist (CBCL-Chinese parent version) and another survey known as the "Current Status Survey" used to collect information from parents. Data analysis showed that 17.3% of the adolescents born with VLBW have emotional and behavioral problems above the clinical cut-off. About 50.8% of all participants had at least one diagnosis while 23% had more than one diagnosis, with the three most common diagnosis being cerebral palsy (24.6%), intellectual disabilities (21.3%) and ADHD (19.7%). The most common psychiatric diagnosis was ADHD (N = 12). Adolescents with ELBW scored higher on social problems in the parental CBCL report and have more diagnosis of ASD when compared with adolescents with birth weights of 1000 – 1499 g. The difference was statistically significant. There was also a gender difference in some of the outcome variables. Boys scored higher on delinquent problems, social problems, attention problems, and externalizing problems compared to girls. The authors suggested that due to the increasing number of preterm children surviving, there is need to appreciate the prevalence of some behavioral disorders, and for the development of "appropriate mental health services and population-specific approaches for screening and treatment" (P. 365).

Preterm Birth, Low Birth Weight and Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder is a range of conditions involving impairment in the following areas– reciprocal interactions, communication and a pattern of repetitive behaviors. The prevalence rate is about 1 to 4 in 1000. Because extremely preterm children have been shown to be at risk for neurodevelopmental disability, behavioral and social problems, it is likely that they will also be at risk for ASD (Johnson et al., 2010). Several studies have linked ASD with LBW (Glasson, Bower, Petterson Klerk, Chaney & Hallmayer, 2004; Hultman, Sparen & Cnattingius, 2002). Although most of these studies based the risk on the screening instrument rather than a diagnosis by a healthcare professional.

One of the studies that showed an association between LBW and diagnostic prevalence of ASD was conducted by Pinto-Martin, Levy, Feldman, Lorenz, Paneth, and Whitaker (2011). They followed over 1,000 adolescents born weighing <2000 g who were born between 1984 and 1989 and followed up by periodic assessments to age 21. Of the over 600 followed up to adolescence, results showed that for the screening prevalence at 16 years of age, about 18.8% (117) screened positive for autism by one or more screening criteria. For the diagnostic prevalence of ASD, of the 70 young adults who were screen positive for adolescents, 11 (14.3%) were found to have ASD and of the 119 who screened negative, 3 were found to have ASD. The ASD in this group was found to be high functioning in terms of IQ and spoken language. The authors stated that the prevalence of ASD diagnosis in children born with low birth in this cohort was 5 times the prevalence reported by the CDC. The study concluded that the rate of ASD is higher among LBW survivors compared to the normal birth weight population.

Additionally, Johnson et al. (2010) investigated the prevalence, correlates, and antecedents of ASD in children born extremely preterm. The study was conducted with children born <26 weeks of gestation in the United Kingdom and Ireland in 1995. ASD screening was conducted for survivors at 11 years. About 219 (71%) of preterm children were assessed and were compared with 153 term-born peers. The assessment was based on parents' reports. Parents were given the Social Communication Questionnaire (SCQ) to assess autism spectrum symptoms in the child. The diagnosis of ASD was done using a psychiatric evaluation. The authors also administered an IQ test and clinical evaluation.

Consequently, the result demonstrated that children who were born extremely preterm scored significantly higher on measures of SCQ compared to their term peers. For the prevalence of ASD symptoms, 15.8% of extremely preterm children and 2.9% of the control group had positive screening results for ASD. The scores were significantly higher for the extremely preterm group. Of the 217 children assessed for ASD, around 8% of those born extremely preterm were assigned an ASD diagnosis, whereas none of the control group was diagnosed with ASD. For the antecedents of ASD in extremely preterm children, higher scores were associated with "increasing weeks in NICU, male sex, lower gestation age (<25 weeks), vaginal breech delivery, abnormal cerebral ultrasound scanning results, and not having had breast milk" were all associated with ASD symptoms independently (P. 525). At 2.5 years, larger head circumference was significantly associated with lower SCQ scores. By age 6, ASD symptoms were independently associated with cognitive impairment, inattention, peer problems and withdrawn behavior. Johnson et al. reaffirmed that extremely preterm children are at greater risk for autism spectrum symptoms and disorders. According to Johnson et al., "the prevalence of narrowly defined autism disorder is approximately 65-times higher than community population, and the prevalence of ASD is 4 to 12 times higher" (Johnson et al., 2010. P. 528). Therefore, the diagnosis of ASD in middle childhood for the extremely preterm group suggested that ASD may result from abnormal brain development due to the birth status of the affected children.

Preterm Birth, Low Birth Weight, and Anxiety

Anxiety is the most common mental health disorder that affects the population, and has a serious effect on the affected person's quality of life, socio-economic consequences as well as decreased learning ability (Sømhovd, Hansen, Brok, Esbjørn, & Greisen, 2012). Several researches have linked anxiety to LBW. A meta-analysis carried out by Sømhovd et al. examining the relations between adolescents who were born with VLBW and their risk of developing anxiety found a significant link between the two. The study included case-control studies of children and adolescents between the ages of 11 and 20. The groups were matched with normal weight in terms of age and sex. The meta-analysis included six studies with 1519 adolescents (787 VLBW and 732 comparisons). The result showed that the general risk of developing clinically significant anxiety problems was almost twice in the VLBW population. Also, the overall prevalence of anxiety disorder was 9.9% in the VLBW group and 5.5% in the comparison group. The result of this study showed that those born with VLBW have a higher risk of developing clinically significant anxiety problems during adolescence compared to the general population. The mechanism of this relationship is likely to involve both biological factors as well as environmental factors according to the authors (Sømhovd et al., 2012).

In contrast, Cook (2004) found no significant difference in the quality of life between preterm and term group between the ages of 19 and 22. The study was comprised of 79 preterm group and 71 term group. The participants were given a questionnaire comprising of the Short Form 36 Health Survey (SF-36), a Social Activities Scale, and the Hospital Anxiety and Depression Scale (HADS). The result showed that the scores for anxiety and depression were similar for both the preterm and term group. Females reported a higher anxiety score than males. Methúsalemsdóttir, Egilson, Guðmundsdóttir, Valdimarsdóttir, and Georgsdóttir (2013) also reported a similar result, where they found that there was no significant difference in the quality of life between adolescents born with ELBW and those born with normal birth weight.

Preterm Birth, Low Birth Weight, and Depression

Data comparing the risks of depression and birth weight have found that young adults who were born with VLBW are predisposed to experiencing depressive symptoms compared to those with normal birth weight. Räikkönen et al. examined whether young adults aged 18 to 27 years who were born with VLBW differ from term control subjects in terms of "depressive symptoms, current use of antidepressant medication, and the rate of depression diagnosed by a physician" (Räikkönen et al., 2008, P.290). The study included 162 VLBW young adults and 172 term not small for gestational age control subjects born in Finland. The depression outcome was assessed using the following: a history of physician-diagnosed depression, history of antidepressant use, Beck Depression Inventory (BDI) score, as well as the Center for Epidemiologic Studies Depression Scale score (CES-D).

The study found that when the VLBW participants born small for gestational age were compared to those born with VLBW and appropriate for gestational age, those born with VLBW and appropriate for gestational age were less likely to report a depressive symptom and a depression diagnosis. On the other hand, participants born with VLBW and small for gestational age reported more depressive symptoms and used antidepressants more frequently compared to the VLBW group born appropriate for gestational age. The small for gestational age group were also more likely to report a depression diagnosis compared to the term controls. This means that the rate of depression was higher for VLBW participants born small for gestational age compared to VLBW infants born appropriate for gestational age. Based on the outcome of this study, Räikkönen et al. suggested that it is possible that the risk of depression in the VLBW participants born small for gestational age could be because of the intrauterine growth retardation suffered prenatally.

Preterm Birth, Low Birth Weight, and Intellectual Disability

Intellectual disability is an important health burden that affects approximately 0.5% of the population in Western countries (De Ligit et al., 2012). This disability is also referred to as cognitive impairment or mental retardation. A diagnosis of severe intellectual disability is generally based on an IQ of between 70-75 or below. Severe intellectual disability is an IQ less than 50 and significant limitations in activities of daily living (De Ligit et al., 2012). Intelligence functioning (IQ) is an important measure to assess the general cognitive impact of LBW and preterm birth on school-age children. The mean IQ tends to decrease with decreasing gestational age. According to research, this decrease is predicted to be approximately 1.7 IQ points per week (Bhutta, Cleves, Casey, Cradock, & Anand 2002; Johnson, 2007). A longitudinal study by Hack et al. investigated the cognitive and educational outcome of early school-age children (6 – 7 years) born with birth weight <750g. The study was conducted using a sample of 68 children born between 1982 and 1986, matched with a control group of children weighing between 750g to 1499g (n = 65) and term children (n = 61). For the <750g group, it was found that they had an estimated IQ that was approximately one standard deviation below the control term groups.

In addition, the study found that almost half of the <750 g group had an intellectual impairment (with 21% exhibiting severe intellectual impairment) when compared to the 750-1499 g (28%) and the term groups (16%). However, when these children were assessed again after four years using the WISC- III (Vocabulary and Block Design), the mean IQ for the <750 g was 78, while the mean IQ for the 750 to 1499 group and term group were 89 and 99 respectively. This means that the estimated IQ for the <750 group declined over a four-year period, and by the time they were in middle school-age, the IQ was approximately 1.5 standard deviation below term peers. In addition, the number of children with severe intellectual impairment has increased to 37% from 2% at early school-age (Hack, Taylor, Klein, Eiben, Schatschneider, & Mercuri-Minich, 1994). The authors concluded that children born weighing less than 750 g who survive are at increased risk for negative neurobehavioral outcomes and poor school performance.

However, when these groups were followed up again at age 16, the mean IQ for the <750 group slightly improved to 83. For the 750g to 1499 g and the term group, the magnitude of the difference in IQ between the <750 g and the term group decrease to approximately one standard deviation (Taylor, Minich, Bangert, Filipek, & Hack, 2004). Based on the above research, children born with ELBW are at an increased risk for intellectual impairment compared to their counterparts born with normal birth weight. Although the above study was conducted with children born in the 80’s, advancement in medical technology and intervention may have some positive impact for children born later, thus, highlighting the need for more research using contemporary cohorts.

Preterm Birth, Low Birth Weight, and Language

Language is another area that may be impacted by LBW and preterm birth. Speech and language impairment is a deficit in communication that negatively affects the child's ability to talk, understand, read, and write. This disorder may be so subtle that they have little or no impact on daily living and socialization. It can also be so severe to result in the inability to produce speech or to understand and use language (Turnbull, Turnbull, & Wehmeyer, 2007). Taylor, Hack, Klein, and Schatschneider (1995) in their study to understand the effect of LBW on language deficit found that, when tested at school-age, children with birth weight lower than 750 g scored significantly lower than their term peers on language composite that measures areas such as phonological processing, verbal comprehension, vocabulary, and verbal memory. The extent of group difference was approximately 0.4 standard deviation. By middle school, the <750 group were still displaying language deficits and performing significantly below the control group on measures assessing the recall of sentences and comprehension. The <750 group performed between 0.7 and 0.8 standard deviation below the term group (Taylor, Klein, Minich, & Hack, 2000). At adolescence, there was also a deficit in the <750 group on a measure of higher order language skills such as identification of synonyms, pragmatic language, and fluent word generation. The score was approximately 0.5 standard deviation below those of the control group (Taylor et al., 2004). This shows that language deficits by children who were born with ELBW continue throughout childhood and into adolescence. LBW puts children at risk for developing language problems.

Similarly, a different study also showed that birth weight and preterm birth increase the risk of some developmental problems. This was a longitudinal study conducted by Hutchinson, Luca, Doyle, Roberts, and Anderson (2013). This study examines the cognitive outcomes of children born extremely preterm/ELBW at age 8.

The study comprised of a cohort of children born at <28 weeks or with birthweight of <1000g in Australia in 1997. The study consisted of a random sampling of 201 extremely preterm infants and 199 term infants. The two groups were matched in terms of age, the mother's country of birth and health insurance status. The study tested a range of intelligence including intellectual ability, general intelligence, verbal comprehension, verbal reasoning ability, perceptual reasoning, visual reasoning abilities, the working memory, the processing speed and academic skills such as reading, spelling, and arithmetic.

Accordingly, the result of the above study showed that the ELBW group scored significantly below the normal weight group on all domains of general intelligence such as perceptual reasoning, verbal comprehension, working memory as well as processing speed. Even after controlling for sociodemographic variables, the difference remained statistically significant. On the test of academic progress, the ELBW group was also found to score significantly lower than the normal birth weight group in terms of reading, spelling, and arithmetic, with the magnitude of the group difference being 0.5 standard deviation (SD) for reading and spelling and 0.6 SD for arithmetic. The outcome of this study showed that the effects of LBW, especially for ELBW can persist until school-age and can affect almost all aspects of cognition and academic skill, even after adjusting for sociodemographic variables. The authors concluded that the significant difference between the ELBW group and the normal weight group across all domains suggests more of a global cognitive deficit instead of impairment in selective domains (Hutchinson et al., 2013).

Furthermore, to show the effect of LBW on cognition in terms of learning and school problems among four countries (Central New Jersey, Central-west Ontario, Bavaria and Holland), Saigal and his colleagues (2003) conducted a study to describe and compare the outcome of school-age children (8 – 11 years) born with ELBW. The researchers followed up some ELBW survivors from birth to mid-childhood to understand the nature and incidence of both short and long-term neurodevelopmental sequelae. There were about 532 live births weighing <1000 g for the four cohorts that completed the study. The analysis showed that there was no significant difference in the incidence of neurosensory impairment such as cerebral palsy and mental retardation for New Jersey, Ontario, and Bavaria (the incidence was 22%. 27% and 25% respectively). Holland had the lowest incidence of neurosensory impairment (11%).

Additionally, the result also showed that a higher proportion of the cohort from New Jersey scored in the normal range in both IQ and achievement measures compared to the other cohorts. Children from Bavaria performed significantly worse on all achievement measures compared with the other three cohorts. In addition, there was no significant difference between the cohorts on the use of special educational assistance. A high percentage of the children from all cohorts were receiving either part-time or full-time special educational assistance. There was no significant difference in grade repetition as the rate of grade repetition range from 19% to 34%. The researchers also checked for the effect of birth weight, sex, and the number of days on mechanical ventilation on IQ. The analysis showed that the number of days on mechanical ventilation was significantly associated with IQ scores among ELBW in the Ontario and Bavarian cohorts.

Therefore, the outcomes of the study show that school-age children who were born with ELBW experience significant disability problem including school-related difficulties and the use of special education resources in all four countries. The study also shows that the difficulties experienced by the EBLW children during school-age have some social and economic consequences in the long term. Although this study did not specify why there is a significant difference between cohorts on certain areas such as IQ and reading problems, they stated that the difference observed could be as a result of one cohort given tests norms standardized several years ago compared to the groups that were given recent ones. Another reason for the difference in arithmetic and spelling between Bavarian and Ontario children, according to the authors, may be that one-quarter of Bavarian children born with ELBW had delayed school entry by at least one year.

Sociodemographic Variables and Outcome Variables

Sociodemographic variables such as parental education and socioeconomic status have been shown to interact with biological factors to influence the individual differences in cognitive outcome (Luciana, 2003). When compared with mothers of term/normal birth weight infants, mothers of LBW infants and preterm infants report a higher level of depression and anxiety as well as higher socioeconomic stress. Also, mothers of LBW /preterm children have also been shown to report higher levels of parenting stress and tend to perceive their children as more demanding, hyperactive and distractible. This may influence these mothers' reports of their children's behavior (Singer, Salvator, Guo, Collin, Lilien & Baley, 1999 cited in Luciana, 2003). Also, there has been a report of a significant negative correlation between the severity of mothers' depression and their children's score on Bayley scales of mental development during infancy. This means that maternal depression, as well as low socioeconomic condition of the family, may predict children's depression, especially for children born with LBW and those born preterm.

However, to assess if medical complications mediate the association between birth status and developmental outcome of preterm/VLBW, and to understand the role of the early social environment on infant development, Miceli et al. (2000) examined a sample of infants born preterm at 4 months, 13 months, and 36 months. Birth status and medical complication information of the infants was collected during the child's NICU stay. The longitudinal study included 30 infants and their mothers admitted at a Level III NICU. To assess maternal distress, Miceli et al. used the Beck Depression Inventory and the Parenting Stress Index at 4 months. Social support was measured using the Dunst Scales. The result showed that, although medical complications accounted for the outcome at 4 and 13 months, however, the outcome at 3 years was predicted by maternal distress level and her perceived social support at 4 months. The result also showed that maternal distress positively correlated with both internalizing and externalizing behaviors in children at 3 years. This study showed that by 3 years, the developmental outcomes of LBW and preterm infants are more closely due to the early social environment rather than the early physiological factors. It is therefore important to understand if the effect of SES will continue into middle childhood, and that is what we hope to understand in this present study.

Although the above study finding was based on a maternal rating of her level of distress and the infant’s behavior, another study that used a more subjective measure in assessment supported the above conclusion (Coley & Nichols, 2016). This study first compared school performance of extremely preterm or LBW children and term control subjects at age 10 years. Next, the study examined the impact of family composition and stability on academic performance. Children born between 24 to 31 weeks of gestational age and of term control subjects were matched socio-demographically and followed up longitudinally from birth. The result showed that socioeconomic status such as increasing parental education, being raised by two parents and long-term stability of family composition as well as geographical residence were associated with optimal academic achievement at age 10. However, medical complications related to birth status had little impact on school outcome (Gross, Mettelman, Dye & Slagle, 2001). These sociodemographic effects were less noticeable among term control subjects. This demonstrates that as children with LBW get older, the effect of early physiological factors may have little influence on the developmental outcome, and what mediates the outcome is the environmental and social factors as predicted by the life course theory.

Statement of Research Questions

Based on the theory and previous empirical work, this study sought to examine the following research questions:

1. Do birth weight and preterm birth predict socio-emotional problems (ADHD, ASD, Anxiety, and Depression) children?
2. Do preterm birth and birth weight predict cognitive deficits (intellectual disabilities and speech/language problems) in children?
3. Will gender moderate the effect of preterm birth on behavioral and cognitive outcomes in children?

Statement of Hypotheses

Based on the above research questions, we hypothesized the following for this study.

Hypothesis 1: We hypothesized that preterm birth and LBW will significantly predict behavioral outcomes in children after adjusting for the sociodemographic variables.

a. For depression, we hypothesized that after holding other variables constant, LBW and preterm birth will significantly predict the odds of the diagnosis of depression in children. That is, children born with LBW and those born preterm will be more likely to be diagnosed with depression compared to those born normal birth weight and the term group.
b. For the ADHD outcome, we hypothesized that LBW and preterm birth will significantly predict the odds of ADHD diagnosis during middle childhood while adjusting for the covariate variables. That is, children born with LBW and those born preterm will have a higher likelihood of being diagnosed with ADHD compared to children born full term and those with normal birth weight.
c. LBW and preterm birth will significantly predict the likelihood of anxiety disorder diagnosis in children after controlling for the effects of sociodemographic variables. That is, children born with LBW and those born preterm will have a higher likelihood of anxiety disorder diagnosis compared to those born at term and the normal weight group.
d. Again, after adjusting for the effect of covariates, LBW and preterm birth will significantly predict the likelihood of ASD diagnosis children. This means that

children born with LBW and those born preterm will be more likely to be diagnosed with ASD compared to those born normal weight and full term.

Hypothesis 2: We hypothesized for this study that birth weight and preterm birth will predict cognitive deficit between 6 – 10 years old.

a. We hypothesized that LBW and preterm birth will significantly predict intellectual disability in children. Children born with LBW and those born preterm will have a higher likelihood of intellectual disability diagnosis compared to those born with normal weight and those born at term.
b. We also hypothesized that LBW and preterm birth will significantly predict language deficit/speech problems while holding other variables in the model constant. That is, children born with LBW and those born preterm will have a higher likelihood of being diagnosed with speech/language problem compared to those born with normal birth weight.

Hypothesis 3: Finally, since demographic factors such as gender has shown to be associated with child-health and well-being (Pastor & Reuben, 2011). Gender was added to predict their moderating/interacting effect on the outcome variable. We, therefore, hypothesized that gender will moderate the effect of preterm birth and behavioral/cognitive outcomes, particularly speech problems in children. This means that the outcome variables will be different for males and females who were born preterm. Preterm birth will have a more significant impact on language for girls compared to boys.

CHAPTER III
METHODOLOGY

General Overview

The present study used a secondary dataset from the Center for Disease Prevention and Control (2011 – 2012 data set). Before accessing this dataset, we contacted the Institutional Review Board and was granted permission to access the dataset. The dataset contains rich information on parents' education, ethnicity, home environment/living condition, birth weight, preterm birth, and cognitive and behavioral indicators. The principal goal of the data collection was to gather data for the assessment of the physical and emotional health of children aged 0 to 17 years in the United States. For this project, we selected children between the ages of 6 and 10 years.

Description of Dataset

The data collection was conducted by the National Center for Health Statistics (NCHS), for the National Survey of Children's Health (NSCH) 2011-2012. The data collection was done through a cross-sectional telephone survey of US households with at least one child within the age of 0 to 17 during the time of the interview. The United States Department of Health and Human Services (DHHS), Health Resources and Services Administration, Maternal and Child Health Bureau, and the Office of the Assistant Secretary funded the NCHS for Planning and Evaluation (National Survey of Children's Health, 2012).

The baseline for the study was created by interviewing parents or guardians about the health of the child. The respondents for the interview were either a parent or guardian with knowledge of the health of the sampled child. Of the households surveyed, 68.6% of the respondents were mothers, 24.2% were fathers, and 7.2% were other relatives or guardians. Data collection was through a list-assisted random-digit-dial (RDD) sample of landline numbers as well as an independent RDD sample of cell-phone numbers. Participants' eligibility was determined by calling the telephone numbers and screening for residential status, and to determine if there is the presence of a 0 to 17-year-old child in the household at the time of the call. For each household, one child was randomly selected for the survey if more than one child lived in the household. About 95,677 detailed child interviews were conducted. The interview length time was about 33 minutes and 6 seconds for the landline sample and 34 minutes and 14 seconds for the cell phone sample. For this study, we are using children within the age range of 6 – 10 years. This is because this age range is the period where the conditions are first noticed and diagnosed.

Measures

Independent variables.

The major independent variables for this study are birth weight and if the child was born preterm or not. The questions asked to gather this information were *"What was selected child's birth weight?".* The respondents provided the weight of the child which was standardized to ounces. To ascertain if the selected child was born preterm or not, they asked: *"was this child born premature, that is, less than 3 weeks before the due date?".* The response was coded into 1 = yes or 0 = no for the preterm birth question.

Dependent variables.

Cognitive Variables. For the outcome variable to understand the effect of the predictor variables on cognition, two variables were used, which are mental intellectual disability and speech/language deficit. Respondents were asked: *"has a doctor or other health care provider ever told you the child had intellectual disability or mental retardation?", "has a doctor or other health provider ever told you the child had speech or language problems?".* The answers were coded as 1 = yes, 0 = no.

Socio-Emotional Variables. For the behavioral outcomes, four variables were used to assess the effect of the predictor variables on behavioral outcomes. The variables are; depression, anxiety, ADHD, ASD. Some of the questions the respondents were asked include -*"has a doctor or other health care provider ever told you that the child had attention deficit disorder or attention deficit hyperactive disorder, that is, ADD or ADHD?" "Has a doctor or other health care provider ever told you that the child had depression?" "Has a doctor or other health care provider ever told you that the child had anxiety problems?" "Has a doctor or other health care provider ever told you that the child had autism, Asperger's disorder, pervasive developmental disorder, or other autism spectrum disorder?".* The answers were coded as (1) yes, (2) no. For the analysis, the responses were dummy coded into yes = 1, no = 0.

Covariates.

Sociodemographic variables. For the sociodemographic variables, eighteen variables were added to the model to predict their effects on the outcome variables. Variables included were: *"Selected child's age in years at interview?".* Sex was recoded into 1 = male, 0 = female. *"What is the selected child's race?"*. Race was coded as 1 = white, 2=black, 3 = others.

To measure SES, the following questions were asked: "*What Is the highest grade, or Year of School You Have (Mother/father Has] Completed?",* the answers were coded as 1 (Less Than High School), 2 (high school), and 3 (More Than High School). This was recoded into 1 = more than high school, 0 = high school and below. To measure the poverty level of the household, the respondents were asked: "*During the Past 12 Months, did [[S.C.]/ Any Child in The Household] Receive Food Stamps or Supplemental Nutrition Assistance Program Benefits?* ". *"At any time during the past 12 months, even for one month, did anyone in this household receive any cash assistance from a state or county welfare program",* and *During the past 12 months, did [[S.C.] / any child in the household] receive free or reduced-cost breakfasts or lunches at school?* The answers were coded as 1 = yes, 0 = no.

Home environment/living condition. This includes the following questions: *Did [S.C.] ever live with anyone who had a problem with alcohol or drugs? Did [S.C.] ever live with a parent or guardian who was divorced or separated after [S.C.] was born? Did [S.C.] ever live with a parent or guardian who died? Did [S.C.] ever live with a parent or guardian who served time in jail or prison after [S.C.] was born? Did [S.C.] ever see or hear any parents, guardians, or any other adults in [his/her] home slap, hit, kick, punch,* *or beat each other up? Was [S.C.] ever the victim of violence or witnessed any violence in [his/her] neighborhood? Did [S.C.] ever live with anyone who was mentally ill or suicidal, or severely depressed for more than a couple of weeks?* These were coded as 1 = yes, 0 = no.

Data Processing

The national survey of children's health dataset, which was assessed from the Center for Disease Control and Prevention database for the 2011-2012 period, had a total sample size of 95,677 for the 50 US states. The dataset contained about 367 observable variables altogether. Statistics for the original data set birth weight were VLBW = 1388, moderate birth weight = 6889, and normal/overweight birth weight = 82754. In addition, for the preterm birth, the statistics were N = 18689 for term birth and N = 2909 for preterm birth. We deleted the variables not currently required for this project and reduced in the number of variables required. We performed checks on variable descriptive to ensure that they contained values and that there were no missing values. The sample size was reduced after the selection of cases based on the age of interest. This reduced the sample size is N = 25,768.

The data file for this study include missing values codes and different missing values were coded differently. Missing data due to respondents not knowing the answer were coded as “6”, or “96”, or “996”. Refused responses were coded as “7”, “97”, or “997”.

Plan of analysis

For this study, the analysis was conducted using SPSS (IBM version 24), a computer statistical package. The statistical procedures used in the main analysis was the binomial logistic regression. The preliminary analysis relied on descriptive statistics and percentages.

For hypothesis 1, the expectation that LBW and preterm birth would predict behavioral problems in children (ADHD, ASD, depression, and anxiety) was tested using several binomial logistic regressions. The analysis was conducted separately for each outcome variable. While preterm birth and birth weight served as independent variables, we also reviewed the outcome for sociodemographic variables such as gender, race, parents' education, home environment, and poverty level.

To test for hypothesis 2, that is, the expectation that LBW and preterm birth would predict cognitive deficit (language deficit and intellectual disability) in children was tested using logistic regression. The analysis was conducted using cognitive outcomes as the dependent variables and preterm birth and LBW as independent variables while sociodemographic variables such as gender, race, parent's education, poverty level, and home environment were used as covariates.

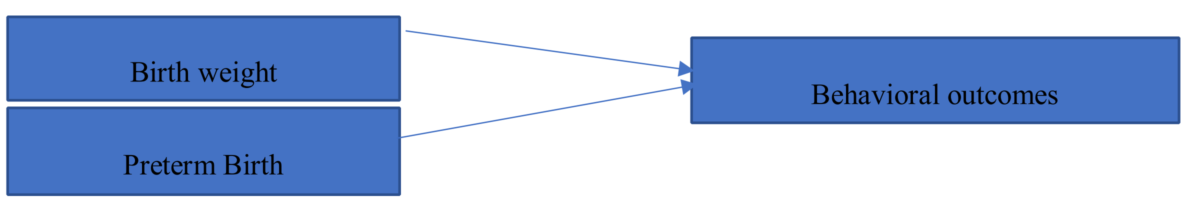

Figure 1. Model for Hypothesis 1

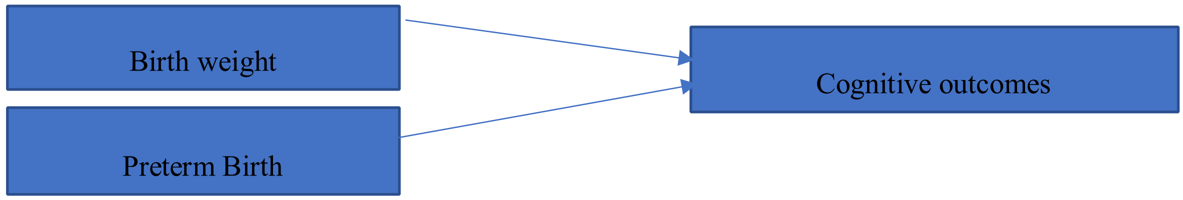

Figure 2. Model for Hypothesis 2

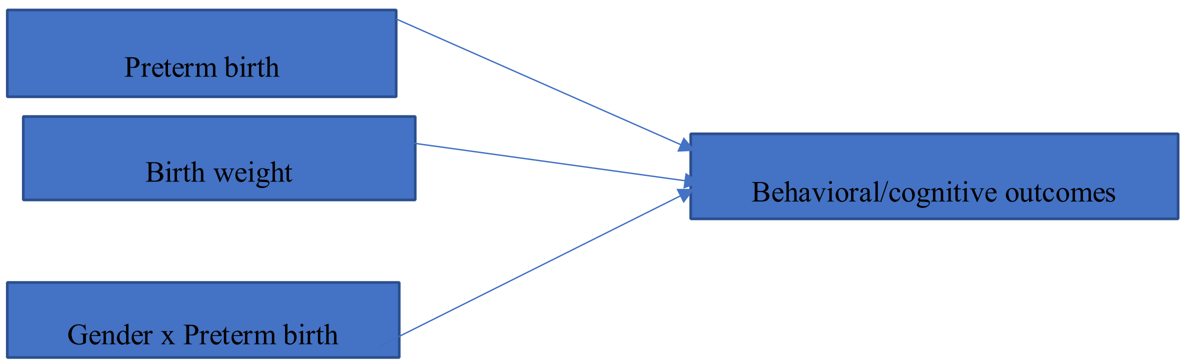

Figure 3. Model for Hypothesis 3

To test for the interaction/moderation between gender and preterm birth on the outcomes, which was the final hypothesis, the interaction was added to the logistic regression in the previous models, to create a new model. This analysis will be used to predict the effect of the interaction of gender and preterm birth on the development of the outcome variables. Only one result of the model that showed a significant interaction effect was interpreted. The result of the significant finding was plotted in a graph to give a picture of the interaction.

The overall model significance for the binomial logistic regression analyses was analyzed by the collective effect of the predictor variables, presented with a χ^2 coefficient. The Nagelkerke R^2 assessed the variability accounted for in the outcome variable by the independent variables. Individual predictors were assessed by the

Wald coefficient. Exp (B) determined the predicted probabilities of the cognitive and behavioral deficits that occurred. For significant predictors, an Exp (*B*) greater than 1 showed that a 1 unit increase in the predictor variable resulted in the dependent variable being X times more likely to be coded 1. Significant predictors with an Exp (*B*) less than 1 were evaluated by 1/Exp (*B*), meaning that a 1 unit increase in the predictor variable was X times more likely to be coded 0.

CHAPTER IV
RESULTS

The purpose of this study was to better understand the factors that predict behavioral (depression, ADHD, anxiety, and ASD) and cognitive problems (intellectual disability and speech problem) during middle childhood and to specifically determine the effects of preterm birth and birth weight in predicting these outcomes. First, the study presents descriptive statistics. Next, it explores the relationship between the dependent and independent variables through logistic regression analyses. Finally, to understand the interacting effect of gender and preterm birth on the outcome variables, a logistic regression is also used to explore how these variables interact.

Preliminary Analysis

Table 1 shows the descriptive statistics for the demographic variables. The initial analysis was conducted using IBM SPSS (Version 24; IBM Corp., 2016). The total sample size for this study was 25,768. The descriptive statistics of some of the key demographic variables were analyzed. It was found that the average age of the respondents was M = 8. For gender, males made up 49.8% while females were 50.2%. The racial and ethnic composition of the study participants was 72.9% White, 10.8% Black, and others = 16.3%. In terms of parents' education, for mothers' level of education, 7.9% completed less than high school, 17.2 % completed high school education, and 74.9% completed more than high school. For the fathers' level of education, about 8% completed less than high school, 21.3% completed high school and 70.7% completed more than high school. Parent's education was dummy coded into 0 (high school and below) and 1 (more than high school).

Table 1. Demographic variables

Variables		N	%
Age (years)	Mean = 8		
Sex	male	10787	49.8
	Female	10868	50.2
Race	White	15357	72.9
	Black	2270	10.8
	Others	3435	16.3
Mother's educ	high school and below	4977	25.1
	More than high school	14816	74.9
Father's educ	high school and below	4969	29.3
	More than high school	11994	70.7
Birth weight group	VLBW	418	1.7
	Moderate birth weight	1961	8
	Normal birth weight	20512	84.1
	Overweight	1501	6.2
Preterm birth	Preterm	2909	13.5
	Term	18689	86.5
Birth Position	1 - Only Child	6285	29
	2 - Oldest Child	6197	28.6
	3 - Second Oldest Child	6826	31.5
	4 - Third Oldest Child	1871	8.6
	5 - Fourth Oldest Child	508	2.3

For the variable on preterm birth, about 18,689 (86.5%) of participants were born at term whereas about 2,909 (13.5%) of the participants were born preterm (that is, 3 weeks before the due date).

Table 2. Demographic variables that estimate poverty level in household

Variables		Yes (%)	No (%)
Received Free/reduced cost meal (43.4)		6246 (56.6)	4787
Received Food Stamp		3781 (34.2)	7262 (65.8)
Received Cash assistance		1060 (9.6)	9965 (90.4)
Had Financial difficulties very often (1)	1404 (5.6)		
Somewhat often (2)	3843 (15.2)		
Rarely (3)	7667 (30.4)		
Never (4)	12319 (48.8)		

For a household where the child receives free lunch/reduced cost meal at school, about 56.6% of households reported yes while about 43.4% reported no. The percentage of those that receive food stamps are 34.2% while about 65.8% of households do not receive food stamp. For cash transfer, 9.6% of households receive cash transfers whereas 90.4% reported that they do not receive cash transfers.

To assess the home environment where the child lives, seven questions were asked and the reported the following. For children that had lived with parents who are divorced/separated, about 19% reported yes, whereas 81% reported no. About 2.9% of the children had lived with a parent/guardian who died while 97.1 % reported no. Again, the percentage of the children who had lived with a parent that had served jail time was

6.7 %. In addition, 6.5% of the children have witnessed family violence while 7 % have been victims of violence. To estimate the incidence of mental health such as depression and suicide, 9% reported living with such a parent. Finally, 10.7% of the children have lived with a parent who had drug problems.

Table 3. Home environment

	No (%)	Yes (%)
Parents divorce/separated	4787 (19)	20471 (81)
Parent died	732 (2.9)	24615(97.1)
A parent jailed	1690 (6.7)	23588 (3.3)
Family violence	1633 (6.5)	23505 (93.5
Victim of violence	1760 (7)	23475 (93)
Parent mentally ill	2260 (9)	22968 (91)
Drug problem	2694 (10.7)	22567(89.3)

For this study, the dependent variable that measures the diagnosis of the outcome variables is YES. A presence of each diagnosis was coded as 1; an absence of each diagnosis was coded as 0, which is considered as the reference group in the binomial logistic regression analyses. In the models, a two-predictor binomial logistic regression model was fitted to the data to test the hypothesis. The hypothesis regards the relation between the likelihood that LBW and preterm birth will predict the odds of the diagnosis of the outcome variables in children while holding other socio-demographic variables constant. We conducted the logistic regression analysis using the Logistic procedure in IBM SPSS statistics 24.

The table below presents the coefficients, the standard errors, the odds ratios, and z tests for the binomial logistic regressions.

Table 4. *Logistic regression predicting the Diagnosis of Depression by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

	Model 1			Model 2		
Variable	B	*SE*	OR	B	*SE*	OR
Constant	17.59***	.969	.001	-7.66***	.973	.000
Birth weight	-.007	.005	.993	-.007	.005	.993
Preterm birth	.692**	.262	1.997	.912*	.394	2.489
Gender male	.897***	.200	2.452	.987***	.238	2.683
(Ref: female)						
Age	.373*	.070	1.451	.374	.070	1.453
Ethnic group						
Black	-.253	.333	.777	-.260	.333	.771
Others	-.239	.246	.788	-.239	.246	.787
(Ref: white)						
Parent's education						
Father's educ	-.167	.211	.846	-.169	.210	.844
Mother's educ	.476*	.211	1.609	476*	.211	1.610
Home Environment						
Parental divorce	.271	.250	1.337	.287	.250	1.332
Parental death	.895*	.416	2.448	.895*	.416	2.446
Parental jail	-1.014	.621	.363	-1.015	.620	.362
Witness P. DV	-.169	.516	.845	-.163	.515	.850
Victim of DV	.319	.430	1.376	.313	.430	1.368
Mentally ill parent	-.108	.401	.898	-.110	.401	.896
Subst. abuse	-.890	.517	.411	-.888	.517	.412
Socioeconomic Status						
Fin. Difficulties	-.031	.104	.969	-.033	.104	.967
Cash assistance	.505	.289	1.657	.510	.289	1.665
Food stamp	.875***	.226	2.400	.869***	.226	2.384
Reduced/free lunch	.570*	.239	1.769	.568	.239	1.766
Preterm birth*Gender				-.325	.443	.723

Note: *$p < .05$. **$p < .01$. ***$p < .001$.

$\chi 2$ (23) = 136.984 $\chi 2$
Nagelkerke R^2 = .118
Classification accuracy % = 98.2

Table 4 shows the result for hypothesis 1A.

Hypothesis 1a stated that preterm birth and LBWwill significantly predict the odds of the diagnosis of depression in children. According to the result, preterm birth was shown to be a significant predictor of depression in children after holding birth weight and other sociodemographic variables constant (B = .692, S.E = .262, Wald = 6.983, d = 1, P < 0.01, Exp(B) = 1.997). In other words, children who were born preterm are more likely to be diagnosed with depression later in life compared to those born at term. In fact, the odds of a preterm child being diagnosed for depression were 1.997 times greater than the odds of depression for term children. This means that for every 1 unit increase in preterm birth, the odds of the diagnosis of depression increases by 1.997 for preterm children compared to the term children. However, birth weight was not associated with the odds of developing depression after controlling for preterm birth and other sociodemographic variables (B = -.007, S.E = .005, Wald = 1.714, d = 1, P = .190, Exp(B) = .993). This part of the hypothesis was not supported.

The overall logistic regression model was statistically significant, (χ^2 (23) = 136.984, $p < .001$). The model explained 12 % (Nagelkerke R^2) of the variance in depression and correctly classified 98.2% of cases. Thus, the hypothesis was supported for preterm birth, but not for birth weight.

In the second model to test for hypothesis 1b, we conducted a second logistic regression model. To check for the effect of the interaction between gender and preterm birth on the odds of diagnosis of depression, the result showed that there was no significant interaction between gender and preterm birth on the odds of diagnosis of depression (B = -.325, S.E = .443, Wald = .538, P = .463, Exp(B) = .723). Therefore, the result of the main effect still holds.

Table 5. *Logistic regression predicting the Diagnosis of ADHD by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

Model 1			Model 2			
Variable	B	*SE*	OR	B	*SE*	OR
Constant	**-3.422*****	**.440**	**.033**	**-3.47*****	**.441**	**.031**
Birth weight	-.007**	.002	.993	-.007**	.002	.994
Preterm birth	.339*	.134	1.403	.577**	.197	1.781
Gender male (Ref: female)	.929***	.092	2.532	1.002***	.104	2.724
Age	.152*	.031	1.165	.152	.031	1.165
Ethnic group						
Black	-.493**	.174	.611	-.499	.173	.607
Others (Ref: white)	-.496***	.120	.609	-.496***	.120	.609
Parent's education						
Father's educ	-.093	.100	.911	-.093	.100	.911
Mother's educ	.072	.100	1.074	.071	.100	1.073
Home Environment						
Parental divorce	1.025	.125	.976	-.028	.125	.972
Parental death	.265	.254	1.304	.260	.254	1.297
Parental jail	-.459*	.222	.632	-.457*	.222	.633
Witness P. DV	.301	.206	1.351	.305	.206	1.357
Victim of DV	-.036	.209	.964	-.045	.209	.956
Mentally ill parent	-.199	.179	.820	-.200	.179	.819
Subst. abuse	-.051	.183	.950	-.048	.183	.953
Socioeconomic Status						
Fin. Difficulties	.008	.050	1.008	.007	.050	1.007
Cash assistance	.306	.158	1.358	.308	.158	1.360
Food stamp	.646***	.108	1.909	.642***	.108	1.901
Free lunch	.371***	.105	1.449	.371***	.105	1.449
Preterm birth*Gender				-.366	.227	.694

Note: **p* < .05. ***p* < .01. ****p* < .001.

$\chi2$ (23) = 331.008 $\chi2$
Nagelkerke R^2 = .103
Classification accuracy % = 90.7

Table 5 shows the result for hypothesis 1B.

The hypothesis proposes that LBW and preterm birth will predict the likelihood of the diagnosis of ADHD in 6 to 10-year-olds while adjusting for the effects of other variables. The result of the analysis shows that both birth weight and preterm birth were significant predictors of the odds of the diagnosis of ADHD in children. For birth weight, the odds of diagnosis of ADHD is negatively associated with birth weight while holding other variables constant (B = -.007, S.E = .002, Wald = 7.043, $p < 0.01$, Exp (B) = .993). That is, for every I unit increase in birth weight, the odds that the child will be diagnosed with ADHD decreases from 1 to .993. This means that increased birth weight is associated with a decreased likelihood of developing ADHD, while LBW is associated with increasing odds of ADHD.

To check if preterm birth is also associated with the odds of developing ADHD in children, the result showed a significant association between the two. According to the logistic model, preterm birth was a significant predictor of the odds of diagnosis of ADHD (B = .339, S.E = .134, Wald = 6.378, P < 0.05, Exp (B) = 1.403). This result shows that preterm birth increases the likelihood that a child will be diagnosed with ADHD during middle childhood. For every 1 unit increase in preterm birth, the odds that the child will be diagnosed with ADHD increases from 1 to 1.403 compared to those born at term while holding other variables constant. This hypothesis was supported. The overall logistic regression model was statistically significant, (χ^2 (23) = 331.0, $p < .01$). The model explained 10 % (Nagelkerke R^2) of the variance in depression and correctly classified 90.7% of cases.

A second logistic regression model was conducted to show the interacting effect between gender and preterm birth on ADHD. The result showed no significant interaction between gender and preterm birth (B =-.366, S.E =.227, Wald = 2.593, P = .107, Exp (B)

= .694).

Table 6. *Logistic Regression Predicting the Diagnosis of Anxiety by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

	Model 1				Model 2		
Variable	B	*SE*	OR		B	*SE*	OR
Constant	-4.30***	.588	.014		-4.30***	.588	.014
Birth weight	-.010**	.003	.990		-.010**	.003	.990
Preterm birth	.367*	.174	1.443		.649**	.234	1.913
Gender male	.473***	.118	1.605		.581***	.135	1.788
(Ref: female)							
Age	.177	.041	1.194		.177	.041	1.194
Ethnic group							
Black	-.913**	.267	.401		-.923**	.267	.397
Others	-.521**	.165	.594		-.522**	.165	.593
(Ref: white)							
Parent's education							
Father's educ	.086	.133	1.090		.085	.133	1.089
Mother's edu	.427**	.137	1.533		.426**	.138	1.531
Home Environment							
Parental divorce.097	.163	1.102		.092	.162	1.096	
Parental death	.042	.356	1.043		.037	.356	1.038
Parental jail	-.485	.299	.616		-.479	.299	.619
Witness P. DV	.278	.269	1.321		.283	.269	1.327
Victim of DV	-.047	.276	.954		-.060	.276	.942
Mentally ill parent	.107	.222	1.113		.106	.222	1.112
Subst. abuse	-.110	.245	.896		-.105	.244	.900
Socioeconomic Status							
Fin. Difficulties	.041	.067	1.042		.039	.067	1.040
Cash assistance	.287	.212	1.332		.292	.212	1.340
Food stamp	.564***	.145	1.758		.556***	.145	1.744
Reduced/free lunch	.499***	.141	1.648		.499***	.141	1.646
Preterm birth*Gender					-.484	.282	.616

Note: *$p < .05$. **$p < .01$. ***$p < .001$.

$\chi 2$ (23) = 147.809 $\chi 2$
Nagelkerke R^2 = .067
Classification accuracy % = 95.2

Table 6 shows the result for hypothesis 1C.

Hypothesis 1c proposes that preterm birth and low birthweight will be significant predictors of anxiety in children. The results from the analysis show the following: While holding preterm birth and other sociodemographic variables in the model constant, birth weight was shown to be a significant predictor of anxiety (B = -.010, S.E = .003, Wald = 8.797, $p < .01$, Exp (B) = .990). The result means that for every 1 unit increase in birth weight, the odds that a child will be diagnosed with anxiety decreases from 1 to .990 compared to children born at term. The odds that a child will be diagnosed with anxiety decreases with increasing birth weight. In order words, the lower the birth weight, the higher the odds that a child will be diagnosed with anxiety, the higher the birth weight, the lower the odds of anxiety.

For preterm birth, the model showed that it was also a significant predictor of anxiety in children after holding other variables in the model constant (B = .367, S.E = .174, Wald = 4.447, p < .05, Exp (B) = 1.443). This means that the odds that a child will be diagnosed with anxiety increase for children born preterm compared to those born at term. That is, for every 1-unit increase in preterm birth, the odds that a child will be diagnosed with anxiety in childhood increases from 1 to 1.443. The overall regression model was statistically significant (χ^2 (23) = 147.809, $p < .001$). The model explained 7 % (Nagelkerke R^2) of the variance in anxiety and correctly classified 95.2% of cases. Therefore, our hypothesis is supported.

In the second model showing the interacting effect of gender and preterm birth on anxiety, the result showed no interaction (B =-.484, S.E =.282, Wald =2.957, P = .085, Exp (B) = .616). Therefore, our main effect still holds that preterm birth predicts anxiety in children, irrespective of the gender.

Table 7. *Logistic regression predicting the Diagnosis of Autism Spectrum Disorder by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

	Model 1			model 2		
Variable	B	*SE*	OR	B	*SE*	OR
Constant	-3.679***	.749	.025	-3.789	.753	.023
Birth weight	-.007	.004	.993	-.007	.004	.99
Preterm birth	.365	.227	1.440	.815*	.337	2.260
Gender male	.959***	.165	2.608	1.114***	.192	3.045
(Ref: female						
Age	.016	.052	1.016	.017	.052	1.017
Ethnic group						
Black	-.443	.299	.642	-.452	.299	.636
Others	-.804**	.243	.448	-.804**	.243	.448
(Ref: white)						
Parent's education						
Father's educ	.381*	.176	1.464	.382*	.176	1.466
Mother's educ	.269	.183	1.309	.267	.183	1.306
Home Environment						
Parental divorce	-.297	.231	.743	-.303	.231	.738
Parental death	.070	.469	1.072	.052	.469	1.053
Parental jail	-.678	.423	.508	-.674	.423	.510
Witness P. DV	-.126	.386	.881	-.125	.386	.882
Victim of DV	.412	.317	1.511	.397	.317	1.488
Mentally ill parent	.355	.268	1.427	.357	.267	1.429
Subst. abuse	.035	.307	1.036	.040	.306	1.041
Socioeconomic Status						
Fin. Difficulties	-.001	.086	.999	-.005	.086	.995
Cash assistance	.198	.325	1.219	.207	.325	1.230
Food stamp	-.108	.202	.897	-.116	.202	.891
Reduced/free lunch	.518**	.173	1.679	.517**	.173	1.676
Preterm birth X gender				-.657	.380	.518

Note: **p* < .05. ***p* < .01. ****p* < .001.

$\chi 2$ (23) = 99.781 $\chi 2$
Nagelkerke R^2 = .064, Classification accuracy % = 97.2

This hypothesis tests the effects of LBW and preterm birth on the diagnosis of ASD. From the analysis, the result shows that neither preterm birth (B = .365, S.E = .227, Wald = 2.587, P = .108, Exp (B) = 1.440), nor birth weight (B = -.007, S.E = .004, Wald = 3.080, P = .079, Exp (B) = .993) were significant predictors of ASD in children even after holding other variables in the model constant. The overall regression model was statistically significant, (χ^2 (23) = 99.791, $p < .001$). The model explained 6% (Nagelkerke R^2) of the variance in ASD and correctly classified 97.2% of cases. For the model to examine the effect of interaction between gender and preterm birth in predicting ASD, the result showed no significant interaction (B = -.657, S.E = .380, Wald = 2.986, P = .084, Exp (B) = .518). This model did not support our initial hypothesis.

However, in the model with the interaction, preterm birth became significant in predicting ASD (B = .815, S.E = .337, Wald = 5.856, P < 0.05, Exp (B) = 2.260), with children born preterm having a higher likelihood of the diagnosis of ASD compared to children born at term. The model shows that for every 1-unit increase in preterm birth, the odds that a child will be diagnosed with ASD increases by 2.260 compared to children who were not born preterm. This means that the odds of the diagnosis of ASD are more than twice for children born preterm compared to those born at term.

However, the overall model was statistically significant (χ^2 (99.791) = 23, $p < .001$). The model explained 6.4% (Nagelkerke R^2) of the variance in ASD and correctly classified 97.2% of cases.

Table 8. *Logistic regression predicting the Diagnosis of Intellectual Disability by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

	Model 1			Model 2		
Variable	B	*SE*	OR	B	*SE*	OR
Constant	-4.42***	.999	.012	-4.39***	1.001	.012
Birth weight	-.020***	.005	.980	-.021***	.005	.980
Preterm birth	.673*	.280	1.961	.579	.377	1.785
Gender male	.289	.204	1.343	.239	.252	1.270
(Ref: female)						
Age	.256**	.074	1.240	.257**	.074	1.293
Ethnic group						
Black	-.611	.435	.543	-.608	.435	.544
Others	-.265	.270	.767	-.264	.270	.768
(Ref: white)						
Parent's education1.053						
Father's educ	.051	.235	1.053	.052	.235	1.053
Mother's educ	-.160	.235	.852	-.161	.235	.852
Home Environment						
Parental divorce	.160	.286	1.173	.165	.286	1.179
Parental death	-17.01	12904.2	.000	-17.01	2905.1	.000
Parental jail	-1.363	.750	.256	-1.368	.750	.255
Witness P. DV	.110	.498	1.116	.111	.498	1.117
Victim of DV	.380	.439	1.465	.388	.440	1.474
Mentally ill parent	.309	.374	1.363	.309	.374	1.362
Subst. abuse	-.288	.462	.750	-.291	.462	.747
Socioeconomic Status						
Fin. Difficulties	-.005	.115	.995	-.003	.115	.997
Cash assistance	.215	.423	1.240	.213	.423	1.237
Food stamp	-.079	.265	.924	-.077	.265	.926
Reduced/free lunch	.325	.238	1.384	.325	.238	1.384
Preterm birth*Gender				.161	.430	1.175

Note: *$p < .05$. **$p < .01$. ***$p < .001$.

$\chi 2$ (23) = 83.873 $\chi 2$
Nagelkerke R^2 = .085
Classification accuracy % = 98.5

This hypothesis proposes that preterm birth and LBW will predict the odds of the diagnosis of intellectual disability in children. The result of the model showed that both preterm birth and birth weight were significant predictors of intellectual disabilities in children even after adjusting for other sociodemographic variables in the model. For birth weight, the result showed that LBW is related to increasing likelihood of diagnosis of intellectual disability (B = -.020, S.E = .005, Wald = 15.261, P < 0.001, Exp (B) = .980). This result means that for every 1-unit increase in birth weight, the odds that a child will be diagnosed with intellectual disability decreases from 1 to .980 after holding other variables in the model constant. This shows that children born with LBW have a higher likelihood of being diagnosed with an intellectual disability compared to those born with normal birth weight. This also supports our hypothesis.

For the effect of preterm birth on the diagnosis of intellectual disability, the model result showed a significant relationship between preterm birth and intellectual disability after adjusting for the effect of other variables in the model. Children born preterm have a higher likelihood of diagnosis of intellectual disability compared to those born at term (B = .673, S.E = .280, Wald = 5.803, P < 0.05, Exp (B) = 1.961). This means that for every 1-unit increase in preterm birth, the odds that a child will be diagnosed with an intellectual disability increases from 1 to 1.961 compared to those born at term. This result shows that the likelihood of being diagnosed with an intellectual disability for children born preterm is almost twice that of children born full term. This part of the hypothesis was also supported.

For this hypothesis, the overall regression model was statistically significant (χ^2 (23) = 83.873, $p < .001$). The model explained 9% (Nagelkerke R^2) of the variance in intellectual disability and correctly classified 98.5% of cases.

For the hypothesis examining the effect of the interaction between gender and preterm birth on the diagnosis of intellectual disability, the result showed no significant interaction between the two (B = .161, *SE* = .430, Wald = .141, *p* =.707, Exp (B) = 1.175). Therefore, the main effect will be kept.

Table 9. *Logistic regression predicting the Diagnosis of Speech or other Language Problems by Birth weight and Preterm birth (model 1) and interaction with gender (model 2)*

	Model 1			Model 2		
Variable	B	*SE*	OR	B	*SE*	OR
Constant	-1.89***	.400	.152	-1.95**	.401	.142
Birth weight	-.006*	.002	.994	-.006*	.002	.994
Preterm birth	.420**	.123	1.523	.694***	.174	2.002
Gender: male	.720***	.082	2.055	.807***	.093	2.242
(Ref: female)						
Age	-.017	.028	.389	-.017	.028	.983
Ethnic group						
Black	-.319*	.154	.727	-.324*	.154	.723
Others	-.582***	.116	.559	-.581***	.116	.559
(Ref: white)						
Parent's education						
Father's educ	.043	.092	1.044	.042	.092	1.043
Mother's edu	.110	.094	1.116	.108	.094	1.114
Home Environment						
Parental divorce	-.123	.116	.884	-.126	.116	.881
Parental death	-.025	.252	.975	-.031	.252	.969
Parental jail	-.248	.189	.780	-.248	.189	.781
Witness P. DV	.259	.184	1.296	.266	.184	1.305
Victim of DV	-0.24	.183	.976	-.037	.183	.964
Mentally ill parent	.051	.152	1.052	.052	.151	1.053
Subst. abuse	.106	.158	1.112	.108	.158	1.115
Socioeconomic Status						
Fin. Difficulties	-.006	.045	.994	-.008	.045	.992
Cash assistance	-.012	.175	.988	-.010	.175	.990
Food stamp	.083	.105	1.086	.078	.105	1.081
Reduced/free lunch	.341***	.094	1.407	.340***	.094	1.406
Preterm birth*gender				-.436*	.204	.646

Note: *$p < .05$. **$p < .01$. ***$p < .001$.

$\chi 2$ (23) = 176.756 $\chi 2$
Nagelkerke R^2 = .051
Classification accuracy % = 89.1

Hypothesis 2b stated that LBW and preterm birth would predict speech or other language problems during middle childhood. The analysis proved that both were significant predictors of speech problems in children. According to the model, birth weight was a significant predictor of speech problems in children after controlling for other variables in the model. This means that LBW increases the odds of speech/language problem diagnosis in middle childhood (B = -.006, S.E = .002, Wald = 6.482, $P < 0.05$, Exp (B) = .994). Therefore, for every 1 unit increase in birth weight, the odds that a child will be diagnosed with speech/language problems decreases by .994.

For the association between preterm birth and the odds of speech problem diagnosis, the result also showed a significant relationship (B = .420, S.E = .123, Wald = 11.748, $P < 0.01$, Exp (B) = 1.523). For every 1 unit increase in preterm birth, the odds that a child will be diagnosed with speech/language problems increases by 1.523 after holding other variables in the model constant. This means that there is a greater likelihood that children who were born preterm will be diagnosed with a speech problem between 6 to 10 years of age compared to those born at term. The overall regression model for this hypothesis was statistically significant (χ^2 (23) = 176.756, $p < .001$). The model explained 5.1% (Nagelkerke R^2) of the variance in speech/language problems and correctly classified 89.1% of cases. Our hypothesis for this model was supported.

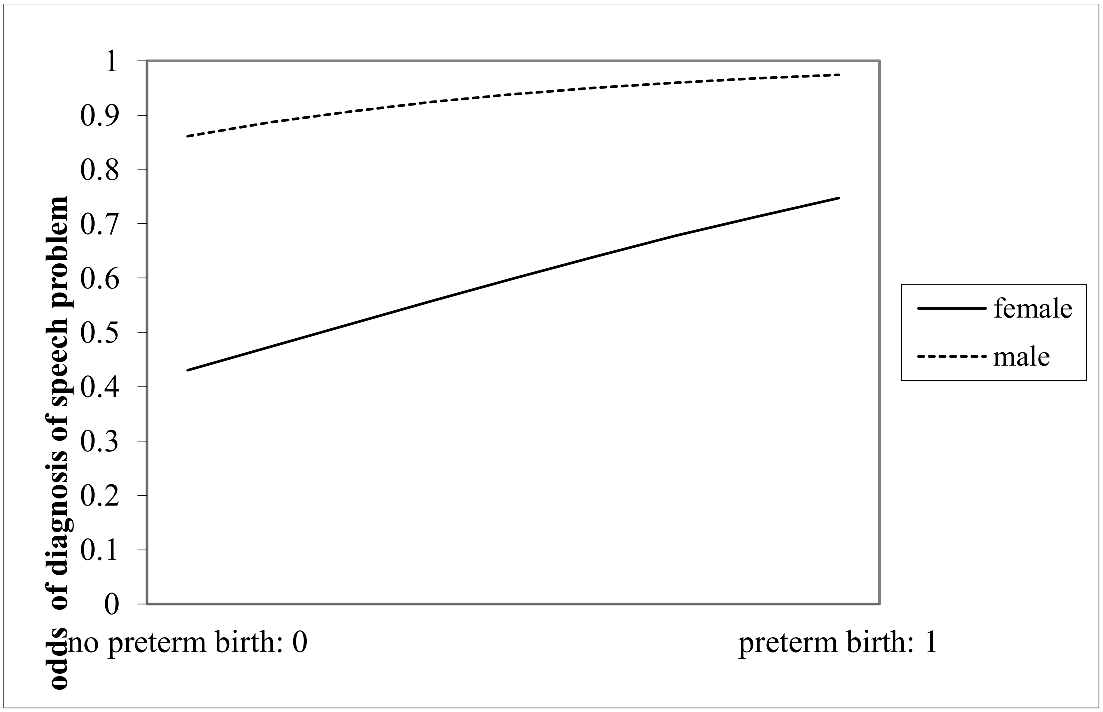

Figure 4: *Plot for interaction between gender x preterm birth on speech problems*

To determine the effect of the interaction between gender and preterm birth on speech problem diagnosis, an interaction was added to the logistic regression model. The result shows that the interaction was statistically significant (B = -.436, S.E = .204, Wald = 4.577, $P < 0.05$, Exp (B) = .646). This means that the gender of the child moderates the significant relationship between preterm birth and language problem. The effect of preterm birth on language differed for boys and girls. The plot above shows that although the mean for males was .861 compared to the mean for the females (.43) in the term group, the mean increased to .974 for males and .75 for females in the preterm group. This means that preterm birth has a more significant impact on language for girls when they are born preterm than when they are born at term compared to boys. The mean for the preterm group increased to almost twice for girls compared to boys. Therefore, both the main effect and the interaction effect are important. This result supports our hypothesis that gender has a moderating effect. The overall interaction model was statistically significant (χ^2 (24) = 181.276, $p < .001$). The model explained 5.3% (Nagelkerke R^2) of the variance in speech/language problems and correctly classified 89.1% of cases.

The effect of Sociodemographic variables on the outcomes

For depression, looking at the sociodemographic variables, gender, age at the time of the interview, mother's education, having lived with a parent who died, receiving food stamps and free lunch at school were all associated with the odds of being diagnosed with depression in childhood. This means that boys, higher maternal education, having ever lived with a parent who died, receiving food stamps and free feeding all increase the odds of developing depression for children. The reason for the relationship between higher maternal education and depression may be that mothers with higher education are more likely to take their child to the hospital for proper diagnosis if they notice any socio-emotional problems compared to mothers with lower levels of education. In addition, living with a parent who died can have a devastating effect on young children as they have to deal with the death of a parent at such a young age. This may result in depression.

For the ADHD outcome, some sociodemographic variables showed to be significant predictors of ADHD diagnosis. They include gender (boys have increased odds of the diagnosis of ADHD by 2.532 compared to girls), age at interview (with older age having more diagnosis compared to younger children), receiving food stamps and free lunch/reduced-cost breakfast at school also significantly increase the likelihood of the diagnosis of ADHD. Ethnicity showed to have a relationship with the diagnosis of

ADHD. The odds of the diagnosis of ADHD decreases by .611 for blacks and .609 for other races compared to white children. Also, living with a parent who served a jail term showed to have a negative relationship with ADHD, as children who lived with a parent that a served jail term are also less likely to be diagnosed with the disorder compared to those whose parents did not serve a jail term.

For the sociodemographic variables predicting anxiety, the result of the analysis shows that gender, ethnicity, mother's education, child's age at the time of the interview, receiving food stamps and free lunch/breakfast are significant predictors of anxiety in children. This means that boys (OR = 1.605), higher maternal education (OR = 1.533), older age at the time of interview (OR = 1.194), and poverty (food stamps/free meal OR = 1.758 and 1.648) increase the odds of anxiety diagnosis compared with girls, lower maternal education, and not receiving food stamps/free feeding. On the other hand, black children and children from other races have a reduced likelihood of being diagnosed with anxiety compared to white children (black OR = .401, other races = 594).

For ASD, the sociodemographic variables that showed to be significant predictors of the odds of diagnosis are gender, race, father's education, and reduced/free meal in school. This means that male children (OR = 2.608) have a higher likelihood of being diagnosed with ASD during childhood compared to female children. This means that boys are more than twice more likely to be diagnosed with autism compared to girls. A father's higher education also increases the odds that a child will be diagnosed with autism compared to children of fathers with lower a level of education. However, children from other races have lower likelihood of being diagnosed of autism compared to white children.

Finally, for speech/language problems, gender, ethnicity, and reduced cost breakfast showed to be significant predictors of the diagnosis of speech problems. Boys have a higher likelihood of being diagnosed with speech problems compared to girls. The odds for a boy is twice the odds for girls (OR = 2.055). For ethnicity, black children and children from other ethnic groups have a decreased odd of diagnosis of speech problems compared to white children. This means that the odds that a black child will be diagnosed with a speech problem decrease by (OR = .727), and the odds for children from other ethnic groups decreases by (.559). On the other hand, receiving free/reduced cost lunch/breakfast at school is also associated with a greater likelihood for the diagnosis speech problems (OR = 1.407). The only sociodemographic variables predicting the likelihood of the diagnosis of intellectual disabilities is age at the time of the interview, with higher age predicting the odds that a child will be diagnosed with an intellectual disability compared to the younger age (OR = 1.292).

CHAPTER V
DISCUSSION

The present study aimed to examine the effects of preterm birth and LBW on socio-emotional and cognitive outcomes of children between the ages of 6 and 11. In this chapter, we highlight three major aspects. First, this chapter reviews the hypotheses stated in Chapter II and the extent to which each was supported. Since multiple factors are associated with a child's developmental outcome and not just biological vulnerability, we will also briefly explain the impact of other factors like sociodemographic factors on the outcome variables. Second, this chapter discusses the strengths and limitations of this research study. Finally, it highlights the conclusions and future directions and implications of this research study.

In this large population-based study, we will see how preterm birth and LBW are linked to the behavioral and cognitive outcomes of children between the ages of 6 and 11. Our study found that both LBW and preterm birth were associated with the odds that a child will be diagnosed with the outcomes tested after adjusting for sociodemographic variables, except for autism.

Preterm birth, Low Birth weight, and Depression

As for depression, we found that children born preterm were more likely to be diagnosed with depression than the term group after adjusting for other variables in the model, whereas LBW was not related to depression in children. This is consistent with some previous studies which documented extremely preterm children's reports on more internalizing behavioral problems such as depression (Farooq et al., 2007).

For birth weight, there is consistency with some studies reporting no relationship between birth weight and depression and others reporting children born with VLBW being less depressed. Interestingly, this was strongly dependent on an intrauterine growth pattern. This study found that the effect of VLBW on depression depends on whether the child was born with VLBW, but appropriate for gestational age or if they were born with VLBW and small for gestational age (Räikkönen et al., 2008). They found that those born with VLBW and small for gestational age reported more depressive symptoms compared to those born with VLBW but appropriate for gestational age. It is possible that in the present study, birth weight was not a significant predictor of depression as we did not divide them into groups based on whether they were small for gestational age or not.

In addition, Bottling, Powls, Cooke, and Marlow (1997) found that children with VLBW showed a trend towards increasing depression compared to children born at a normal birth weight. This result contrasts with our findings that showed no relationship between birth weight and depression. Other studies found no difference between young adults with VLBW and a normal birth weight group (Cooke, 2004; Bjerager, Steensberg & Greisen, 1995). When we added the interacting effect of gender, it showed that gender did not have any moderating effect on the relationship between preterm birth and depression. The reason for this difference in outcome may be that the above authors used screening methods and grouped the children into birth weight, while our studies relied on a diagnosis by a medical professional and did not group children into birth weight groups. Rather, we used birth weight as a continuous variable rather than a grouping variable.

Surprisingly, boys were more likely found to be diagnosed with depression than girls even after adjusting for other variables. This result was unexpected as some studies found that girls tend to have a higher depression rate than boys (Andst et al., 2002;

Karger, 2014). In terms of maternal education, a higher maternal education is linked with a higher diagnosis of depression. Again, having lived with one parent who died was also linked with a higher diagnosis of depression. The reason may be that mothers who have a higher education are more likely to notice their children's abnormal behavior, and more likely to seek help compared to mothers with a lesser education. However, studies have shown that certain behaviors such as depression have been linked to family factors. Parents who have experienced psychological problems such as depression or suicide are more likely to have children who also show a susceptibility to emotional problems (Gennaro et al., 1990). This was not the case for the present study, as there was no significant relationship between living with a parent who had a psychological problem and the diagnosis of depression. Other sociodemographic variables such as race and father's education were not associated with depression.

Preterm Birth, Low Birth Weight, and ADHD

In terms of ADHD diagnosis, the preterm group was found to be more vulnerable to ADHD at 6 - 10 years of age. This showed that both preterm birth and birth weight were significant predictors of ADHD in children. Our finding is in accordance with previous studies. For example, Farooq et al. (2007) found that parents and teachers reported more ADHD symptoms in a preterm group compared to the term groups. These effects were largely independent of sociodemographic confounders. The risk for ADHD in children born preterm was about 1.4 compared to the risk for those born at term. This is in line with the findings by Lindstrom, Lindblad, and Hjern (2011) who found that the risk of ADHD increases with the increasing degree of immaturity. In addition, Farooqi, Hägglöf, Sedin, Gothefors, and Serenius (2007) found that the odds of ADHD medication use in the preterm groups were higher than the odds for term groups. Johnson and Marlow (2011) also found a similar pattern where extremely preterm and ELBW groups were more likely to be diagnosed with ADHD compared to the term group.

Similarly, previous studies have also reported a higher incidence of ADHD in children who were born too early or too small (Szatmari et al., 1993). This supports our findings that LBW and preterm birth increase the odds of being diagnosed with ADHD. The risk for ADHD in the preterm group may be related to brain development. ADHD development could be a result of the delay in cortical maturation (Shaw et al., 2007). According to studies, cortical refinement peaks at 24 to 28 weeks, and the number of neurons peaks at around 28 weeks (Marsh, Gerber, & Peterson, 2008). Therefore, children born very or extremely preterm may be lacking in this.

However, given the significance of childhood socioeconomic factors on psychological outcomes of children born preterm and with LBW, we examined developmental outcomes after accounting for sociodemographic characteristics. These include gender, the child’s age at interview, receiving food stamps and free launch which increase the risk of ADHD diagnosis for children. Boys were shown to have increased odds of the diagnosis of ADHD compared to girls. In our study, boys had a greater likelihood of being diagnosed with ADHD compared to girls. Low SES increased the risk of psychiatric hospitalization in both adolescents and young adults who were born preterm (Lindstrom & Lindblad, 2009). This was consistent with our study, as children who receive food stamps and free launch at school were shown to have higher odds of ADHD diagnosis. This may be because these are probably markers for a complex network of risk factors that are related to social difficulties such as relative poverty, residing in low-status housing areas, and family discord. Bottling, Powls, Cooke, and Marlow (1997) also found that children with LBW were more vulnerable to psychiatric disorders such as ADHD. Although this study was based on screening behaviors rather than a diagnosis by a professional. The difference between our study and the above study may be due to the time the two studies were conducted. Bottling and his colleagues used participants born between 1980 and mid-1981, and our study was carried out with participants born in the 2000's. Improved healthcare in the early 2000's may have an impact on the outcome for children with LBW compared to those born in the early 1980's.

Preterm Birth, Low Birth Weight, and Anxiety

For the relationship between anxiety, preterm birth, and birth weight, our data showed that birth weight was a significant predictor of anxiety in children. This means that the lower the birth weight, the higher the odds of developing an anxiety disorder in school-age children. Again, our data showed that preterm birth was also a significant predictor of anxiety, as children born preterm have higher odds of being diagnosed with anxiety disorders compared to the term group. This study supports other studies that found a similar result. For example, a meta-analysis study conducted by SomHovd et al. (2012) found that adolescents born either preterm or with LBW have more than a two-fold risk of having anxiety symptoms compared to the normal birth weight and term children. However, the result of SomHovd study indicated higher odds of anxiety compared to our study. Levy-Shiff et al. (1994) also found a significant relationship between birth weight and anxiety. Their study found that in a group of 13-to 14-year olds, those born with VLBW exhibited more anxiety behaviors compared to the matched normal weight group. Similarly, Dahl et al. (2006) also found more overall behavioral problems including anxiety disorders in the VLBW group of 13-and 18-year olds compared with normal samples.

Consequently, the higher prevalence rate of a clinically significant risk of anxiety diagnosis found among the preterm group and lower birth weight may be because of several factors. Anxiety may be because of the difference in brain functioning directly as a result of birth circumstances. The pre-frontal cortex and amygdala are both involved in anxiety. The amygdala may be impaired in preterm/LBW children (Davidson, 2002). Research also suggests that impairments in the executive and attention functions, which are dependent on the pre-frontal functioning, are overrepresented in those born preterm (Ni, Huang & Guo, 2011).

Again, looking at the sociodemographic variables and their relationship to anxiety, our study found that gender, ethnicity, mother's education, and child's age at the time of interview as well as receiving food stamps and free meals at school were significant predictors. The risk of anxiety was found to be higher in boys and children with higher maternal education. Older children also tended to have a higher risk of being diagnosed with an anxiety disorder compared to younger children. In addition, a higher poverty level was associated with a higher risk of anxiety. Surprisingly, the risk of anxiety was lower among black children and children from other ethnic groups compared to white children. The reason may be that for race, decreasing odds of diagnosis may be because minorities are less likely to be diagnosed by medical personnel, as their symptoms are often attributed to nurture - bad parenting and life stresses while the behavioral symptoms in White children are more likely to be attributed to biology. For the age at interview, our study contrasts with the meta-analysis by SomHovd et al (2012), which found that a younger age demonstrated more clinically significant anxiety symptoms than older age categories. Although their study focused on clinical symptoms, ours focused on a diagnosis by a professional. The reason for higher maternal education may be that mothers with a college degree are more likely to notice an abnormal behavior in their children and are more likely to seek help. This is also true for higher-income families who are more likely to take their children to a healthcare professional for proper diagnosis and management. The same also goes for ethnic minorities, as they are less likely to be diagnosed with behavioral problems and get appropriate treatment compared to their white counterparts (Kail, 2012).

Preterm Birth, Low Birth Weight, and Autism Spectrum Disorder

As for ASD, there was no significant association with birth weight and preterm birth after adjusting for the effects of all of the sociodemographic variables. This was in contrast to some previous studies that found a significant relationship between preterm birth, birth weight and ASD.

Surprisingly, when we added the interaction effect of gender and preterm birth to the model, preterm birth became a significant predictor of autism, with the preterm group having more than twice the odds of developing autism compared to the term group. With this twist, our hypothesis is supported but only after adding the gender and preterm interaction. Previous research seemed to support this finding. A research study carried out in Asia showed that children and adolescents born preterm with LBW had more emotional and behavioral problems such as autism compared to the term and normal weight group (Yang et al., 2015). It should be noted that this study was conducted with adolescents born with VLBW and extremely preterm, while our study only had one preterm group and treated birth weight as a continuous variable. Other by Pinto-Martin et al (2011) supported the link between birth weight and ASD. They estimated that the prevalence of ASD in children with VLBW was 5%.

Johnson et al (2010) found a link between autism and preterm birth. Their study found that the prevalence of ASD was about 2 to 4 times higher than the general population. The reason for the discrepancy between their findings and our finding before the interaction was added to our model may be that we did not use screening tool. Instead, the present study used a diagnosis by a professional. Also, the criteria for defining preterm in our study was children being born three weeks before the due date. Therefore, we didn't have different preterm groups; we only had a preterm group and a term group. The reason for the relationship between autism and preterm birth (after the interaction was added) may be because of increased risk of neurodevelopmental impairments that occurs with decreasing gestational age (Moster, Lie & Markestad, 2008).

In addition, we did find that gender, ethnicity, father's education, and receiving free lunch showed to be significant predictors of ASD. Boys have higher odds of being diagnosed with autism, with the odds for boys being at least twice as high than girls (Johnson et al., 2010). Fathers having more education was also a significant predictor of autism in children. This may be because fathers who have higher education are also more likely to have higher-income. Thus, they are more likely to take their children for proper diagnosis if they notice any abnormal behavior compared to those with lower education. The data also showed that other races have lower odds of an autism diagnosis compared to children from white or black ethnic groups. Children who receive free lunch at school also have a higher odds of autism diagnosis. The reason may be that those who had been diagnosed with autism are more likely to be attending special schools, where they are more likely to be served free food compared to children attending regular schools.

Preterm birth, Low Birth Weight and Intellectual Disabilities

As for intellectual disability, we found that both preterm birth and LBW are linked to the diagnosis of intellectual disability. This was in line with a meta-analysis conducted by Brydges, Landes, Reid, Campbell, French and Anderson (2018) which found a strong association between very preterm birth and intelligence, including executive functioning and processing speed. This study found that children and adolescents who were born very preterm scored below their peers on intelligence measures. This suggests that children born preterm especially those born very preterm and extremely preterm, are more likely to have cognitive impairments compared to those born at term. The reason for the cognitive impairment may be because of incomplete perinatal neural development, as the extremely and very preterm may be born before the completion of the neural development (Brydges et al., 2018).

Furthermore, a study by Bhutta and his colleagues also found a similar outcome. In their study using a cohort of children born in the 1990s, it was found that the preterm/LBW group had a deficit in IQ compared to the term/normal birth weight group (Bhutta, Cleves, Cradock, & Anad, 2002). The study also showed that IQs decline by 1.7 to 2.5 points with each week's decrease in gestational age. This means that due to a decline in IQ with decreasing gestational age, children born preterm, especially those born extremely preterm or very preterm are more likely to be diagnosed with intellectual disability during school-age. In contrast, Kerr-Wilson et al reported a significant relationship between gestational age and intelligence, but not birth weight and intelligence (Kerr-Wilson, Mackay, Smith, & Pell. 2012).

Finally, when considering the effects of sociodemographic variables on learning disability, we found that only age at interview showed an association. This means that higher age at interview means greater odds of the diagnosis of learning disability. This makes sense because the children have fully started school and if the children are not reading or learning well compared to their classmates, they are likely to be checked for learning problems.

Preterm birth, Low Birth Weight, and Language Deficit/Speech problems

In terms of language deficit, we found that LBW and preterm birth were associated with the odds of the diagnosis of language problems after adjusting for sociodemographic factors. The works of previous researchers support our study. Ortiz-Mantilla et al. (2008) found that the VLBW children scored lower on all standardized language measures compared to normal birth weight children, even though VLBW children's overall language performance was within the normal range. Mantilla et al. suggested that the lower language score could be due to global processing deficit rather than specific ability in the language domain. A global processing means the ability to process language holistically. That is, being able to process language as a whole and not just specific aspects of the language. The relationship between LBW and language deficit is consistent with the expectation that children with LBW will perform below their counterparts with normal weight in the language domain.

Furthermore, for the aspects of language that involve reading and spelling, a previous study by Hutchinson et al (2013) found that the odds of reading and spelling impairment in the extremely preterm and ELBW groups were approximately double the odds for term and normal birth weight group. This finding is in line with the present study that preterm children or lower birth weight were more likely to be diagnosed with language deficit compared to the term or higher birth weight group.

In contrast to our findings, Wolke and Meyer (1998) found that when controlling for general cognitive performance, the analysis found no specific language deficit for preterm children. The reason for this contradictory finding may be that language deficit may not be because of damage in a specific region of the brain responsible for language, but because of a more general cognitive deficit associated with decreasing gestational age. The present study did not control for general cognitive performance, this might explain the difference in finding.

Next, for sociodemographic variables relating to language/speech problems, we found that boys have higher odds of having language problems compared to girls. In fact, the risk for boys developing speech/language deficit is more than twice the risk for girls in our study. This is not surprising as many previous studies have found similar results. Boys are generally susceptible to a wide range of perinatal outcomes and disabilities including language deficit (Wolke, Samara, Bracewell, Marlow & EPICure study group, 2007). White children also showed greater odds of being diagnosed with language/speech problems compared to black children and other ethnic groups. In addition, higher poverty level, which was measured by receiving free/low-cost food at school, was associated with speech problems diagnosis.

However, the finding for the moderating effect of gender on the relation between preterm birth and our outcome variables was also interesting. The study showed a significant interaction between gender and language problems. Boys generally tend to have a higher diagnosis of speech problems compared to girls. However, the impact of preterm birth was significantly higher for girls when they are born preterm compared to boys. Significant sex differences in cognitive functioning, including language deficit, have been reported in some previous studies (Wolke et al., 2008). The above authors found that extremely preterm boys had a significant increase in language deficit compared to girls born extremely preterm. This is in line with our study that found a substantial and clinically relevant increase in language difficulties in preterm boys compared with preterm girls. This supports research that there are lower survival and more incidence of neonatal problems (Costeloe, Hennessy, Gibson, Marlow & Wilkinson., 2000), and higher rates of disability (Wood et al., 2000) in males in this population. The reason for this gender difference may be as a result of the sex differences in intrauterine development that makes the male fetus more susceptible to perinatal adversity, which may have significant consequences for later development (Kraemer, 2000 cited in Wolke et al., 2008).

Nevertheless, it is vital to note that most previous studies were based on grouping gestational age based on the degree of prematurity, while our study is based on whether the child was born preterm or not. Birth weight was used as a continuous variable rather than a grouping variable. Furthermore, most of the current study that examined the developmental outcomes of children born preterm and with LBW used various neurodevelopmental assessment tools. However, our outcomes were based on diagnosis by a health professional as reported by the parents, and the presence of the outcomes was coded in terms of whether the 'behavioral/cognitive problem' has been officially issued to the child.

Study Strengths and Limitations

Strengths

The strength of this study is that we used a sample size that is nationally representative and not based on a specific region in the country (N = 25,768). The sample population is also diverse in terms of race, sex, and SES. This means that we can generalize the outcome of this study across the United States. The large sample size is able to provide the statistical power required to test the various hypotheses and proposed group differences that were examined in this research project. Thus, we are confident that our significant findings show that the predictor variables are true predictors of the problems tested. Another strength of this study is that the outcome variables were based on a diagnosis by a professional, while most previous studies used screening assessments to determine the effects of preterm birth and birth weight.

Finally, our study's strength is also in the use of a contemporary cohort (children born in the early 2000's) as previous studies have used participants born several decades ago (1970's, 1980's, and 1990's). This is important to note because of the advancement in medical care that has occurred in recent years, which can affect the outcome of these children. Again, the moderation model helps us to understand that language deficit is different for boys and girls who are born preterm. That is, girls tend to develop more language problems if they are born preterm compared to if they are born at term. While boys tend to have more language problems generally.

Limitations

A notable limitation of this study is that parent's reporting of the child's health can have a response bias. We did not directly measure/assess the children's cognitive and behavioral outcomes but rather relied on the report of parents. Pastor and Reuben (2011) show that mothers often underreported child health that was poor or worse. Therefore, some parents may fail to report if their child has been diagnosed with a condition or fail to give accurate information about the child's birth status such as preterm birth and birth weight. Another limitation is that our study did not show the gestational ages of the preterm group. This could have helped us group the preterm into the different groups based on the degree of prematurity. Moreover, we did not adjust for the effects of various early interventions the children received. A strong body of research has shown that early childhood intervention programs for at-risk children have a positive effect on preventing developmental delay (Anderson et al., 2003; Spittle, Orton, Anderson, Boyd & Doyle, 2012). Without considering the effect of the intervention programs, we cannot say for sure if the data reflects a biologically determined outcome for these children.

Implication of the study

The real-world benefit of this study is that the outcome can influence policies, so that special intervention programs can be designed for the at-risk group. This can help the most affected children cope with both academic and social life. The study can also help ensure that already-developed programs are properly implemented.

Future Directions

The main findings in this study include that birth weight and preterm birth can put children at risk for depression, anxiety, ASD, ADHD, intellectual disability, and language deficit. However, this raises the question of whether problems may increase in severity as gestational age decreases. That is, are children more likely to be diagnosed with these conditions if they were born very and extremely preterm compared to if they were born preterm. We also know that even late-preterm infants had less desirable cognitive functioning compared to full-term infants (Shah et al., 2016). Although some studies proved this (Yang et al., 2015; Pinto-Martin et al., 2011), further research needs to use larger and more representative samples. In addition, studies about other neonatal risk factors such high birth weight, either because of *in-utero* over nutrition resulting from maternal overnutrition, overweight and/or diabetes during pregnancy are needed. Another future direction is to understand why some preterm children do not develop some of these outcomes while others, and the associated factors. Also, in the future, we will like to understand if there are prenatal or maternal factors (Such as drug use) that are responsible for the preterm birth and low birth weight, and therefore, might be responsible for the observed outcomes.

Another future direction of this research project includes an exploration of the behavioral and cognitive outcomes for the different groups of children born in developing countries and comparisons of their outcomes to those obtained from developed countries. Children born preterm/LBW in poorer countries may be worse-off compared to those born in developed countries because of the huge difference in medical care (Grantham-McGregor, Cheung, Cueto, Glewwe, Richter, Strupp, & International Child Development Steering Group, 2007). In addition, when understanding the long-term consequences of LBW/preterm birth, it is important to follow the affected individuals throughout childhood, adolescence and ultimately into adulthood. Therefore, in our future study, it is important that we conduct a similar study where we follow up on the children from infancy into adolescence and adulthood to know if the outcomes persist into adulthood.

Conclusion

The current study suggests that birth weight and preterm birth are related to socio-emotional and cognitive problems in children between the ages of 6 and 11. This study showed that affected children can be significantly disadvantaged in areas such as anxiety, depression, ADHD, language and intellectual deficits compared to their peers who were born at term or with higher birth weight, even after adjusting for the sociodemographic variables. The only exception is autism, as the result didn't show any relation with preterm birth or birth weight. These findings are consistent with several previous studies that found similar results. The generalizability of this current study is limited by the number of years that have passed since the birth of these children.

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APPENDIX

I. INDEPENDENT VARIABLES

1. K2Q04 What Was [S.C.]'S Birth Weight - (Standardized to Ounces)
2. K2Q05 Was [S.C.] Born Prematurely, That Is, More Than 3 Weeks Before [His/Her] Due Date?

   (1) Yes

   (0) No

   (6) Don't Know

   (7) Refused

II. DEPENDENT VARIABLES

Moderating variable

1. K1Q01 is child male or female?

   1 = Male

   2 = Female

   6 = Don't Know

   7 = Refused

List of Variables That Address Cognitive Outcomes

1. K7Q11 Does [S.C.] Have A Health Problem, Condition, Or Disability for Which [He/She] Has A Written Intervention Plan Called an Individualized Education Program or IEP?

   (1) Yes

   (2) No

   (77) Don't Know

   (99) Refused

2. K2Q36A Has a Doctor or Other Healthcare Provider Ever Told You That [S.C.] Had Any Developmental Delay?

   (1) Yes

   (2) No

   (77) Don't Know

   (99) Refused

3. K2Q60A Has A Doctor or Other Healthcare Provider Ever Told You That [S.C.] Had Intellectual Disability or Mental Retardation?
   - (1) Yes
   - (2) No
   - (77) Don’t Know
   - (99) Refused

4. K2Q37A Has A Doctor or Other Health Care Provider Ever Told You That [S.C.] Had Speech or Other Language Problems?
   - (1) Yes
   - (2) No
   - (77) Don’t Know
   - (99) Refused

List of Variables That Address Behavioral Outcomes.

1. K2Q31A Has A Doctor or Other Health Care Provider Ever Told You That [S.C.] Had Attention Deficit Disorder or Attention Deficit Hyperactive Disorder, That Is, ADD or ADHD?
   - (1) Yes
   - (2) No
   - (77) Don’t Know
   - (99) Refused
2. K2Q32A Has A Doctor or Other Health Care Provider Ever Told You That [S.C.] Had Depression?
   - (1) Yes
   - (2) No
   - (77) Don’t Know
   - (99) Refused

3. K2Q33A Has A Doctor or Other Health Care Provider Ever Told You That

[S.C.] Had Anxiety Problems?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

4. K2Q35A Has A Doctor or Other Health Care Provider Ever Told You That [S.C.] Had Autism, Asperger's Disorder, Pervasive Developmental Disorder, Or Other Autism Spectrum Disorder?

1 = Yes

2 = No

6 = Don't Know

7 = Refused

III. CONTROL VARIABLES

2. K11Q02 Please choose one or more of the following categories to describe [S.C.]'s race.

(1) WHITE / CAUCASIAN
(2) BLACK/AFRICAN-AMERICAN
(3) AMERICAN INDIAN / NATIVEAMERICAN
(4) ALASKA NATIVE
(5) ASIAN
(6) NATIVE HAWAIIAN
(7) PACIFIC ISLANDER
(8) OTHER [RECORD VERBATIM RESPONSE ATK11Q02_OS]
(96) DON'T KNOW
(97) REFUSED

3. AGEYR_CHILD Selected Child's Age in Years at Interview
4. Birth Position of the S.C Relative to Other Children in The Household

1 - Only Child

2 - Oldest Child

3 - Second Oldest Child

4 - Third Oldest Child

5 - Fourth Oldest Child

5. K11Q20: EDUC_MOMR. What Is the Highest Grade or Year of School [You Have / [S.C.]'S [Mother Type] Has] Completed?
    1 - Less Than High School
    2 - High School Graduate
    3 - More Than High School
    6 - Don't Know
    7 – Refused

6. EDUC_DADR. What Is the Highest Grade or Year of School [You Have / [S.C.]'S [Father Type] Has] Completed?
    1 - Less Than High School
    2 - High School Graduate
    3 - More Than High School
    6 - Don't Know
    7 – Refused
7. K11Q61 During the Past 12 Months, did [[S.C.]/ Any Child in The Household] Receive Food Stamps or Supplemental Nutrition Assistance Program Benefits?
    L - Legitimate Skip
    M - Missing in Error
    P - Partial Interview
    0 - No
    1 - Yes
    6 - Don't Know
    7 - Refused
8. K11Q62 During the Past 12 Months, did [[S.C.] / Any Child in The Household] Receive Free or Reduced-Cost Breakfasts or Lunches at School?
    L - Legitimate Skip
    M - Missing in Error
    P - Partial Interview
    0 - No

1 - Yes

6 - Don't Know

7 - Refused

9. K11Q60 At any time during the past 12 months, even for one month, did anyone in this household receive any cash assistance from a state or county welfare program, such as [STATE TANFNAME]?

(1) YES
(0) NO
(6) DON'T KNOW
(7) REFUSED

10. ACE1: Since [S.C.] was born, how often has it been very hard to get by on your family's income, for example, it was hard to cover the basics like food or housing?

(1) VERY OFTEN
(2) SOMEWHAT OFTEN
(3) RARELY
(4) NEVER
(77) DON'T KNOW
(99) REFUSED

11. ACE3: Did [S.C.] ever live with a parent or guardian who got divorced or separated after [S.C.] was born?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

12. ACE4: Did [S.C.] ever live with a parent or guardian who died?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

13. ACE 5: Did [S.C.] ever live with a parent or guardian who served time in jail or

prison after [S.C.] was born?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

14. ACE6: Did [S.C.] ever see or hear any parents, guardians, or any other adults in [his/her] home slap, hit, kick, punch, or beat each other up?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

15. ACE7: Was [S.C.] ever the victim of violence or witnessed any violence in [his/her] neighborhood?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

16. ACE 8: Did [S.C.] ever live with anyone who was mentally ill or suicidal, or severely depressed for more than a couple of weeks?

(1) Yes

(2) No

(77) Don't Know

(99) Refused

17. ACE9: Did [S.C.] ever live with anyone who had a problem with alcohol or drugs?

(1) Yes

(2) No

(77) Don’t Know

(99) Refused