The relationship between premature birth and obesity among children aged 10 to 17 years in the U.S.

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**Abstract**

*Background*: Prematurity is the leading cause in infant mortality in the United States. Approximately one third of all infant deaths can be attributed in some manner to prematurity. Some studies show that preterm births are linked to childhood obesity. One major hypothesis that may suggest an association between preterm births and obesity later in life is the period of "catch up growth" fast weight gain that occurs after birth. Preterm infants may be programmed to eat more to compensate weight gain and growth. This capstone investigates the association between premature birth and obesity among children aged 10 to 17 years in the U.S.

*Methods*: The National Survey of Children's Health was conducted via telephone using a list-assisted random digital-dial (RDD), and cellular phones number to collect various data from children aged 10 to 17 years old. Two variables were used for this study. The independent variable was prematurity, and the dependent variable was body mass index (BMI). Pearson's Chi Square tests and logistic regression were used to examine the relationship between prematurity status and body mass index (BMI).

*Results*: Of the 39,834 ten to seventeen year old children in the sample, 4,226 (10.60%) were born premature. Premature children were more likely to live in a single parent household than non-premature children. Premature children were also more likely to have public health insurance and have unemployed parents than non-premature children. Using Pearson's Chi square tests, participants tended to be underweight, overweight, or obese if they were born premature. Race significantly predicted both dichotomous BMI and categorical BMI. Logistic regression was used to compare the effects of prematurity on the dichotomous BMI variable controlling for various demographics. There tended to be an association between prematurity and

dichotomous BMI in the uncontrolled model (p=0.093). When controlling for demographics and TV watching, there was no association between prematurity and dichotomous BMI.

*Discussion:* There were some differences in body weight percentages between adolescents who were born premature and those who were not born premature. Adolescents that were born premature tended to have body weights other than the normal ranging either too high or too low. These results suggest that prematurity may play some role in weight gain. More research is needed to determine if and how weight gain and premature births are associated.

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## Introduction

Prematurity is the leading cause in infant mortality in the United States. Approximately one third of all infant deaths can be related in some manner to prematurity (Center for Disease Control and Prevention, 2015**)**. Globally, the United States consistently ranks among the top 10 nations for number of preterm births, ranking in at sixth place overall (Blencowe, Cousens, Oestergard, Chou, Mollerr, Narwal, & Lawn, 2012). Some studies found that premature birth was linked with childhood obesity. One major hypothesis that may suggest a connection between preterm births and obesity developing later in life is the period of fast weight gain after birth (Casey et al., 2012; Gaskins et al., 2010; Kato et al., 2015; Litvinchuk et al., 2014; Zarrati et al., 2013; Euser et al., 2005). In order to grow at a rate close to babies who are carried full term, preterm infants are programmed to eat more to gain weight, and compensate growth (Litvinchuk, Singh, Sheehan, & Vasylyeva, 2014). The purpose of this study is to investigate the relationship between premature birth and obesity among children aged 10 to 17 years old in the United States.

### Public Health Significance/Rationale

Preterm birth is a significant health concern. In 2013 worldwide, preterm births complications resulted in one million infant deaths, making it the leading cause of infant mortality amongst children under the age of five (World Health Organization, 2015). Preterm births can set the infant up for lifelong health problems such as learning disabilities, vision and hearing impairment, poor motor skills, and various cognitive disorders (Vasylyeva, Barche, Chennasamudram, Sheehan, Singh & Okogbo, 2013).

Premature births is a substantial burden for the U.S. The total cost associated with preterm birth is estimated to be as high as $26 billion USD (Hodek, Von der Schulenburg &

Mittendorf, 2011). Preterm birth has an emotional and significant financial toll on the families due to accrued medical expenses, loss of parental work productivity as a result of caring for the child, and interventions targeted at improving developmental outcomes amongst children born too early (Hodek et al., 2011). One health concern that may be associated with preterm birth is childhood obesity. The number of overweight and obese children has increased tremendously over the years. Childhood and adolescent obesity has consequences on overall health that continue through adulthood (Vasylyeva et al., 2013). The public health significance of premature birth and obesity are further discussed in the subsequent literature review sections.

## Premature Births and Obesity background

Premature birth is associated with increased morbidity amongst newborn infants, and in the United States approximately one third of all infant deaths can be attributed in some manner to prematurity (Center for Disease Control and Prevention, 2015). Based on recent global estimates, the number of premature births that occur each year is greater than 15 million (World Health Organization, 2015). Worldwide in 2013 preterm birth complications resulted in approximately one million infant deaths, making them one of the leading causes of mortality amongst children under the age of five (World Health Organization, 2015). Nationwide it is estimated that premature births will account for nearly one out of every nine U.S. births. Globally, the United States consistently ranks in the top 10 nations for number of preterm births, and in 2010 was ranked 6$^{th}$ highest overall (Blencowe, Cousens, Oestergard, Chou, Moller, Narwal, & Lawn, 2012). In the United States in 2013, about one-third (36%) of infant deaths were due to preterm-related causes (Center for Disease Control and Prevention, 2015). Annually preterm birth is estimated to cost the United States economy approximately $51,000 USD for each child born premature (Hodek et al., 2011). The total cost associated with preterm birth in the United States

is estimated to potentially be as high as $26 billion USD (Hodek et al., 2011). This total cost takes into account not only the medical expenses accrued but also lost parental work productivity as a result of caring for the child, as well as interventions targeted at improving developmental outcomes amongst prematurely born children (Hodek et al., 2011).

Premature births have been linked with childhood obesity due to fast infancy weight gain. In order to grow at a rate close to babies who are carried full term, premature babies need to receive good nutrition so they are programmed to eat more to compensate growth, and weight gain (Litvinchuk, Singh, Sheehan, & Vasylyeva, 2014). The prevalence of childhood obesity has increased dramatically during the past decades all over the world (Lifshitz, 2008). The number of overweight or obese infants and young children (aged 0 to 5 years) increased for 32 million globally in 1990 to 42 million in 2013 (World Health Organization, 2014). In the United States in 2011-2014, the prevalence of obesity has remained fairly stable at about 17% and affects about 12.7 million children and adolescents age ranging from 2-19 (Center for Disease Control and Prevention, 2014). Childhood and adolescent obesity has several adverse consequences on overall health and leads to premature mortality and increased physical morbidity in adulthood. (Vasylyeva, Barche, Chennasamudram, Sheehan, Singh & Okogbo, 2013). Premature births can set the infant up to many lifelong problems. One problem in particular is obesity. Weight gain methods introduced early on in life to babies whose growth was restricted in the womb may result in obesity during childhood and adolescent years. Later in this paper, under the preterm birth and obesity later in life "section", I will describe in more detail how preterm birth and obesity may be associated.

## Definition of Premature Birth and Obesity amongst Adolescent

The formal definition of a premature birth is an infant birth occurring prior to the child reaching a 37 week gestational age (Goldenberg, Culhane & Iams, 2008). Preterm infants are then typically designated into one of three subcategories, according to the World Health Organization, based on their gestational age at birth. These categories include "extremely preterm", for a gestational age under 28 weeks, "very preterm", for a gestational age between 28 and 32 weeks, and "moderate to late preterm", for a gestational age between 32 and 37 weeks. According to the Center for Disease Control, "overweight is defined by an extremely high body mass index above the 85$^{th}$ percentile and below the 95$^{th}$ percentile for children and teens of the same sex and age. Obesity is defined as a BMI at or above the 95$^{th}$ percentile for children and teens of the same sex and age" (cdc.gov, 2011-2014). A 95$^{th}$ percentile or higher of this particular measure is a good indicator of increase body fat.

## Overview of Preterm Birth Risk Factors

There is no one singular cause associated with premature birth. There are however a series of risk factors that have been shown to contribute to the increased likelihood of the occurrence of a premature birth. These risk factors include but are not limited to: having previous preterm births, pregnancy with twins or multiples, vitro fertilization, problems with the placenta, smoking cigarettes and/or using illicit drugs, unhealthy eating habits, infections in the lower genital tract, high blood pressure and diabetes, stressful life events, multiple miscarriages or abortions, physical trauma, and limited access to health care. Below, I will discuss major risk factors in preterm births.

## Major Risk Factors of Preterm Births

### *Multiple maternal biological/physical/non-modifiable factors*

In addition, multiple maternal biological factors have been shown to increase the likelihood that a premature birth will occur including but not limited to: vascular disease, inflammation, infection, pre-eclampsia, eclampsia, uterine over distention, and intrauterine growth restrictions (Giurgescu, England, Zenk, & Kavanaugh, 2013). Vascular disease and pre-eclampsia causes the placenta which is the source that supplies the food to the unborn infant to detach from the womb too early. Vascular disease and pre-eclampsia causes massive bleeding, and can be very dangerous for the unborn child and the mother (Goldberg et al., 2008). Untreated inflammation and intrauterine growth restrictions can cause preterm births due to the presence of inflammatory mediators in utero. The inflammatory mediator have been linked with fetal injury affecting the brain, lungs and in some severe cases death (Goldberg et al., 2008). Nutrient deficiencies, and alcohol use or smoking by the mother are also considered risk factors which may result in preterm birth. Unhealthy behavior and selfish lifestyle decisions such as smoking during pregnancy has been associated with the development of cardiovascular disease in women. Developing cardiovascular disease can cause preterm birth if untreated (Goldberg et al., 2008). Another risk factor with smoking during pregnancy is sudden infant distress syndrome (SIDS), it can cause low birth weight, and still births due to lack of oxygen, and growth development while the infant is in the womb (Center for Disease and Prevention, 2017). Bacterial Vaginosis (BV) has been recognized as a preterm birth risk factor for maternal mothers. Bacterial Vaginosis is an abnormal balance in the vaginal area of the female body (Paul, Boutain, Manhart, & Hitti, 2008). Symptoms associated with (BV) such as foul odor and a heavy discharge are similar to a common bacterial infection, however many cases are asymptomatic and many women are unaware that the imbalance occurs in their bodies (Paul, et al., 2008). BV is linked with low income African American women, and numerous stressful events that occurred in the maternal

mother's life. These threatening issues alter the mothers PH balance causing infections and other organisms to colonize the genital tract (Paul, et al., 2008).

### *Behavioral and Environmental Factors*

Not only does behavioral factors influence birth outcomes, environments plays a significant role in whether a baby is full term or preterm. E*nvironmental factors* such as air pollution, exposure to hazards associated with abandoned buildings and older homes, and blight as everyday scenery are all stressful life events that can contribute to preterm births. In addition, social determinants such as poverty, violent crimes in the community, and having a partner who served repeated jail terms are also contributors to the maternal health also contributing preterm birth outcomes (Giurgescu et al., 2013).

B*ehavioral factors* of the mother may be involved in addition to stressful conditions listed such as cigarette smoking, drinking alcohol, using drugs, not going for preventive care visits, consume enormous amounts of caffeine and alcohol, and gets accustomed to eating unhealthy foods (Giurgescu et al., 2013) and not taking folic acid supplements. Such unhealthy behaviors listed above exhibit the highest levels of depression and anxiety compared to their counterparts who quit during pregnancy (Giurgescu et al., 2013). All these factors can affect the growth of the unborn fetus and also the birth outcome.

So far I have talked about behavioral and environmental factors, and how these factors may be associated with low birth weight. Now I will talk about low socioeconomic status. All factors mentioned above are also related to socioeconomic status (SES). Low socioeconomic status such as lack of education, lack of healthcare or resource options due to poverty affects and determines ones outcome in relation to pre term or full term births.

### *Low Socioeconomic Status*

According to Center for Disease and Prevention, socioeconomic status is a composite measure that typically incorporates economic, social, and work status. Economic status is measured by income. Social status is measured by education, and work status is measured by occupation (Center for Disease and Prevention, 2014). An Important factor which is linked with premature birth is low socioeconomic status. Low socioeconomic groups also have a greater incidence of heart disease, stroke, and some cancers in adults (James, Nelson, Ralph & Leather, 1997). Low socioeconomic status can be associated with poorer health education, limited access to healthcare resources including prenatal care, poverty, and lack of taking folic acid. Folic acid is a vitamin our body uses to make cells, and helps prevent major birth defects (cdc.gov, 2017). Many women especially African American women experience these components which puts them at a higher risk for preterm births. It is theorized that certain unhealthy behaviors which are more prevalent in individuals with lower socioeconomic status, including drug use, alcohol, and smoking might be a possible explanation for the link between low socioeconomic status and preterm birth. It is also theorized that women who are in the opposite position have better, healthier outcomes with birth. They possess more knowledge, money, and social connectedness.

***Racial disparities and the link between racial discrimination and preterm birth***

Preterm birth has also been shown to affect a disproportionate number of African American women in the United States. According to data from the March of Dimes Organization, 13.4% of African American live births in the United States occur preterm, compared to only 9.1% of Caucasian live births (March of Dimes, 2015). It is theorized that lower socioeconomic status and an increased potential for experiencing racial discrimination might be possible explanations for this disparity. A study of 72 African American women, in 2012, located in the area of Chicago Illinois concluded that experiencing racial discrimination on

an interpersonal level could be associated with increased levels of psychological distress (Giurgescu, Zenk, Dancy, Park, Dieber, & Block, 2012). Another study of 112 pregnant women, 57 were non-Hispanic white, and 55 were non-Hispanic black located in the area of Chicago Illinois concluded that non-Hispanic black women reported more discrimination, food insecurity, and had higher levels of biological markers of stress, C-reactive protein (CRP) and adrenocorticotropic hormone (ACTH) (Borders, Wolfe, Qadir, Kim, Holl & Grobman, 2015). This study also suggest more research is needed to investigate mechanisms underlying differences, and relationships to pregnancy outcomes (Borders et al., 2015). The last study of 39 pregnant women in their second trimester, (19 African American, 20 Whites) located in Columbus, Ohio completed a Trier Social Stress Test (TSST) where characteristics, health behaviors, and affective responses were assessed (Christian, Glaser, Porter, & Iams, 2013). The study concluded that African American women showed a significantly greater inflammatory response. Individual difference in stress induced inflammatory responses represent clear target for continued research efforts in racial disparities in health during pregnancy (Christian et al., 2013). These chronic levels of stress which are correlated with experiencing discrimination provide a possible explanation for the association between preterm birth and racial discrimination. Therefore racial discrimination can directly impact preterm birth, and can have an indirect relationship to preterm birth as increased stress levels associated with racial discrimination can lead to other health problems (e.g., cardiovascular system, suppressed immune system, and metabolic syndrome, which are risk factors that increase the likelihood of a premature birth.

***Multiple gestations as a risk for preterm birth***

Multiple births such as twins and triplets pregnancies are a radically distinctive pregnancy population that have high risks for preterm and late preterm births. Carrying twins, triplets or other forms of multiples, having previously had a preterm delivery, and back to back pregnancies within a short time frame have all lead to complications of preterm delivery. The majority of twins delivered represents 3% of all births in the USA. Twins and triplets account for 26% of all births in late preterm birth period (Refuerzo, 2012). The majority of twins delivered represents 3% of all births in the USA. Twins and triplets account for 26% of all births in late preterm birth period (Refuerzo, 2012).

Thirty percent of preterm births are spontaneous births amongst twins and triplets. The rate of preeclampsia is 2-3 times higher in twins and triplets than in a single birth. Another risk factor for multiple infant births is low birth weight. Twenty-four percent of multiple births infants are born with low birth weight in later preterm period. Morbidity and mortality is another risk factor for multiple births due to complications with, respiratory distress syndrome (RDS), sepsis, intraventricular hemorrhage (IVH), phototherapy and intubation in delivery room in those born late preterm are increased compared to those born after 37 weeks (Refuerzo, 2012).

***Maternal Age***

Maternal age has been shown to influence pregnancy outcomes. Women of advanced maternal age and pregnancy during adolescent are more likely to result in preterm births. Women that are older than 35 are at risk for preterm birth due to having preexisting conditions like hypertension, and diabetes which both pose risk factors with the placenta development, growth of the fetus, and can cause preterm birth. Women younger than 18 had greater odds for developing severe preeclampsia, eclampsia, postpartum hemorrhage, poor fetal growth, and fetal distress (Cavazo-Rehg, Krauss, Spitznagel, Bommarito, Madden, Olsen, & Bierut, 2015) which

puts them at risk for preterm birth deliveries. The next section talks about prematurity and developing obesity later in life.

***Premature Birth and Obesity Later in Life***

Prior studies have shown that obesity was common in low birth weight preterm infants during childhood and adolescence. Fewer studies look at a potential link between being born premature and developing obesity later in life. Studies in this area by (Kato, Kubota, Saito & Takahashi, 2015) often have conflicting results. The Kato et al., study revealed that underweight is a more serious problem than obesity in low birth weight children (Kato et al., 2015). The Kato et al., study involved 177 children (93 boys, 84 girls) who were considered low birth weight infants, and 2,485 (1267 boys, 1218 girls) who were normal birth weight (Kato et al., 2015). There were limitation due to the retrospective design used which resulted in a substantial number of children without present address at time of investigation and questionnaire return rate of 37% (Kato et al., 2015).

Most studies show a positive association between prematurity/low birth weight and the later development of obesity (Zarrati et al., 2013; Casey et al., 2012; Euser et al., 2005). The Casey et al study revealed that obesity status is common in low birth weight preterm infants during childhood, and prevalence varies by weight category (Casey et al., 2012). There were 985 total in participants for this study using a design with two birth weight categories (n=377) was the intervention group, and (n = 608) non-intervention groups. Limitations for this study is the sample to a contemporary group of low birth weight preterm infants was restricted, the medical and nutritional care of the low birth weight preterm babies born at that time varies from current treatment practices. In addition the cohort did not include a large number of extremely low birth weight infants, and 89% of the original sample was available for data collection during youth

years, despite significant efforts to evaluate the entire longitudinal study from birth. The effects loss of subjects on these results in uncertain.

Another study that show a positive association between prematurity/low birth weight and the later development of obesity is the study by (Euser, Finken, Deijzer-Veen, Hille, Wit, Dekker, & Dutch, 2005). The population for this study was a total of 415 participants (194 males), and (221 females) aged 19 years old who were born very premature. The results revealed that infants born very preterm is positively associated with adult body size (Euser et al., 2005). The limitation for this study was there may have been an interference of the effects of possible programming, and the effects of prematurity on BMI and body composition. In addition the results may not be generalized to infants born at term (Euser et al., 2005).

Other studies show no correlation (Litvinchuk et al., 2014; Kato et al., 2015; Gaskins et al., 2010) between prematurity/low birth weight and the later development of obesity. The Litvinchuk et al study revealed a difference in early childhood weight gain dynamics with weight groups noted at 6 months of age that persisted later in life, and increased risk of obesity could be identified very early in infancy among preterm children (Litvinchuk et al., 2014). One limitation for this study was the fact that they were unable to consider the whole spectrum of clinical data, including detailed nutrition and care in the NICU (Litvinchuk et. al., 2014). These conflicting results are likely due to the wide variety of factors that can contribute to the development of obesity in an individual (Casey et al., 2012).

There have been many studies done on the effects that maternal obesity has in leading to premature birth. A disadvantage of these previous studies typically comes from their sampling process. Several studies were conducted outside of the United States (Kato et al., 2015; Zarrati et al., 2013; Euser et al., 2005; Hofman et al., 2004). Other studies focused solely on one

geographic area (Litvinchuk et al., 2014). Two of the previously mentioned studies Casey et al., and Gaskins et al., did use a more nationally representative set of data; pulling from 8 and 4 medical centers across the United States, respectively. By using data from the National Survey of Children's Health, the present study hopes to expand upon those previous studies in order to provide a more encompassing and representative national sample.

***Hypothesis on Why Premature Birth and Obesity May Be Related***

One major hypothesis which links prematurity in infants and obesity later in life is the period of "catch up growth" and weight gain that occurs after the child is born (Casey et al., 2012; Gaskins et al., 2010; Kato et al., 2015; Litvinchuk et al., 2014; Zarrati et al., 2013; Euser et al., 2005). The "catch up growth" procedure potentially explains the disparity in results, as the lower the weight premature infants are, the less likely the pre term infant will become obese due to requiring more nutrients and milk to be considered normal weight (Casey et al., 2012; Kato et al., 2015). A 2004 study by (Hofman, Reagan, Jackson, Jeffries, Knight, Robinson, & Cutfield, 2004) found a link between being born prematurely and the development of an insulin resistance which is a risk factor contributing to the development of Type II Diabetes. The study examined 72 children (50 born premature and 22 controls), who were born at varying gestational ages, between the ages of 4 and 10 years old. When insulin sensitivity was measured the study found that children born premature, regardless of birth weight or gestational age, showed a reduced level of insulin sensitivity in comparison to the control group (Hofman et al., 2004).

The study by (Litvinchuk et al., 2014) noted a similar trend in insulin sensitivity amongst prematurely born infants by the time they reached the age of four. An alternative hypothesis linking these conditions regards the consumption of formula as opposed to natural breast milk during early infancy. The use of formula is common amongst prematurely born infants in order

to facilitate catch up growth (Litvinchuk et al., 2014), however multiple studies have proven that formula consumption could possibly result in complications of metabolic health later in life due to aggressive nutrition (Hay, 2013). A study of 37 premature pediatric patients in Texas found that formula was used more frequently in the obese group (70%) compared to the normal weight group (59%) (Litvinchuk et al., 2014). Breastfeeding duration has been noted by other studies to have an impact on the health on the developmental health of children (Zarrati et al., 2013; Cole, 2007).

### *Prior Studies Associated with Low Birthweight, Obesity, and Insulin Resistance*

Table 1 depicts prior studies that have been conducted on the association of low birth weight, obesity, and how insulin resistance may play a role in developing type 2 diabetes later on in life. Studies have shown that obesity in childhood and adolescence has adverse consequences on overall health and leads to premature mortality and increased physical morbidity in adulthood (Vasylyeva, Barche, Chennasamudram, Sheehan, Singh, & Okogbo, 2013). Obesity, type 2 diabetes mellitus, hypertension, coronary artery disease and stroke might be the health consequences of being born preterm (Vasylyev et al., 2013). Methods such as "catch up growth" used for preterm infants to gain weight fast may be a factor in why preterm infants become obese during their childhood and adolescent years.

Prematurity is another significant medical problem, and studies have shown the correlation of preterm birth and obesity due to using the catch up growth method. Rapid weight gain after a period of nutritional restriction is associated with the development of insulin resistance and metabolic syndrome later in life (Litvinchuk, Singh, Sheehan, & Vasylyeva, 2014). Insulin resistance is a well-recognized, early metabolic abnormality in the pathogenesis of

these adult-onset diseases and usually precedes clinically apparent symptoms (Hoffman et al., 2004). Prior studies have shown that food management early on in the infant's life, and increase physical activity during childhood and adolescent years may be the solution for obesity. .

The particular studies above on prematurity, insulin resistance, and obesity all relate to fostering healthy eating habits. Obesity is the main focus of the three because it has detrimental consequences later on in life. Primary care pediatricians and registered dieticians have a leading role in understanding the associated risk factors and initiating early interventions including diet modifications and diet regimen adjustments to provide essential care for the lifelong well-being of premature children (Vasylyeva et al., 2013), although more research of the different factors mentioned earlier in this paragraph needs to be conducted. Future research should examine the bi-directional association between obesity and additional factors affecting children who were born premature.

**The Barker Hypothesis**

The **"*Barker hypothesis*"** was projected in 1990 by a British epidemiologist named David Barker. The Barker hypothesis is primarily concerned with development, the course of growth of an organism in utero (ScottYoshizawa, 2012). Barkers Hypothesis derived from a historical cohort study that revealed a significant association between the occurrence of hypertension and coronary heart disease in middle age and premature birth or low birth weight (www. Oxford reference.com). Barker believed through geographical studies which led to the hypothesis that undernourishment in utero and the duration of infancy has everlasting changes on the body's structure, and how it functions, which can lead to secondary issues such as coronary heart disease and stroke later on in an adult's life span (ScottYoshizawa, 2012).

### *Concepts of the Barker hypothesis*

The Barker hypothesis has had a very important strong effect on the study of reproduction and disease. The two key conceptions of the Barker hypothesis is developmental plasticity and fetal programming which offers an explanation on the cause of obesity (Scott Yoshizawa, 2012). Barker believed that birth weight, which is associated with a whole host of diseases and chronic illnesses later in life including hypertension, diabetes, and obesity is used as a proxy to measure babies with low birth weight are understood to have been more nutritionally deprived in the womb that their chubby counterparts (ScottYoshizawa, 2012).

Some argue that the "Barker hypothesis" is just a theory of fetal development, and that the hypothesis can support the redistribution of expertise necessary to address a controversy topic such as obesity, so therefore the hypothesis should be significant for transdisciplinary studies of health and disease (ScottYoshizawa, 2012). The Barkers hypothesis suggests that infants who starve in the mother's uterus are more than likely to become overweight or obese and suffer diseases secondary to obesity later on in life. In reviewing this theory, my opinion of this theory is that there are other considerations beyond the mothers eating habit that could possibly modify or impact the infant's growth and lead to life threatening diseases later in life such as genetic factors. Genetics can strongly influence how the infants develop as well.

Limitations of prior studies have shown either a positive link or no association at all between premature births and obesity, suggesting that more research is needed. I hypothesize to find in this study a positive association amongst premature births and obesity. The methods used to help premature infants gain and maintain a healthy weight and growth pattern during the

postnatal period could possibly cause long term adverse illnesses later on in life. This is why there is such a need for this particular study.

## Methods

### *Survey and Study Sample*

Given the current gaps in literature, I investigated the effect on obesity that premature birth had on individuals 17 years old and younger, in order to aid in the design of an intervention program with the goal of improving health status later in life. In order to facilitate the comparison in obesity status between premature and non-premature born children, we utilized data gathered from the most recently available National Survey of Children's Health (NSCH). The NSCH is able to provide a representative sample of all non-institutionalized children and adolescents in the United States.

The National Center for Health Statistics, in partnership with the Centers for Disease Control and Prevention administers the National Survey of Children's Health (NSCH) via telephone, with sponsorship from the Maternal and Child Health Bureau. The NSCH has been conducted periodically ever since it first began in 2003. The 2011-2012 survey conducted anywhere from 1,811 to 2,200 interviews in each US state. Information collected by the survey for approximately 95,677 children up to the age of 17 years old included demographic data, the child's mental and physical health status, as well as whether the family had access to quality medical care.

In order to gather data for the NSCH landline phones were sampled using a list-assisted random digit-dial (RDD) and cellular phone numbers were sampled using an independent RDD to provide supplemental data to the landline sample. These numbers were called in a random fashion in order to find potential households in which there was at least one child who was under

18 years of age. If one of the households surveyed contained multiple children who met the inclusion criteria then one child in that household would be selected randomly. Surveys were completed by the member of the household who considered themselves the most knowledgeable regarding the child's health status. In the cases where monetary incentive was used in order promote survey participation, these incentives did not exceed $15 per household. Overall the average response rate for the 2011-2012 survey was 23.0%, with 38.2% of landlines and 15.5% of cellular devices sampled responding.[15] The surveys were administered in a multiple languages, including English, Spanish, Korean, Mandarin, Cantonese, and Vietnamese, depending on the predominant language of the household being surveyed. The Research Ethics Review Board of the National Center for Health Statistics' approved all the data collection procedures which were utilized for the 2011-2012 NSCH. Research on a variety of topics has been conducted and published by researchers using the data from this, and prior years, National Survey of Children's Health. The National Survey of Children's Health from 2011-2012 marks the first time the survey included a question regarding premature birth. This survey in particular is advantageous because it gathers data on a wide variety of conditions which could potentially be associated with the effects of being born preterm as well.

***Independent and Dependent Variables***

Looking only at children and adolescents under the age of 18 years old (henceforth referred to collectively as "children") there are a total of 39,844 subjects included in the present study who have complete sets data. In order to gather data regarding the independent variable, prematurity, the NSCH used the following question: "Was selected child born premature, that is, more than 3 weeks before his/her due date?"

BMI was used as a dependent variable for this study. The variable "BMI class" divides weight into four categories: underweight for children under the 5$^{th}$ percentile in weight, of adequate weight for children between the 5$^{th}$ and 85$^{th}$ percentile, overweight for children between the 85$^{th}$ and 95$^{th}$ percentile, and obese for children above the 95$^{th}$ percentile. This variable was also transformed into a dichotomous indicator differentiating children of a health weight (85$^{th}$ percentile or lower) and overweight (for children above the 85$^{th}$ percentile).

***Socio-Demographic Factors***

Variables included in this study are: child's race/ethnicity, child's gender, primary language, the relation of the survey respondent to the child, healthcare coverage, household employment status, whether or not the household in question where the child resides is considered "working poor", and the number of adults residing in the household (Table 2). Race/ethnicity was classified as one of five distinct categories: Hispanic, black non-Hispanic, white non-Hispanic, other non-Hispanic, and multiracial. Primary language, which is classified as the language spoken most frequently in the household, was split into only two categories; English and other. The type of healthcare coverage the household received was classified as being either public healthcare coverage or private healthcare coverage. Respondent's relationship to the child in question was categorized as either maternal, paternal, or other. There were three potential responses for the prompt regarding the number of adults who resided in the household; 1 adult, 2 adults, or 3 or more adults.

To collect data on poverty status, the survey gathered information on whether or not the household in which the child currently resided would be considered "working poor". In order to be classified as working poor, a household must have at least one parent employed, working a full time job, with an annual income below the established federal poverty level (FPL). A survey

question regarding whether or not a member of the household had been working at minimum 50 weeks out of the previous 52 was included for analysis purposes, in order to gain a better understanding regarding employment status.

### *Analyses*

Analyses were performed using IBM SPSS 23.0. Pearson's chi-square tests were used to compare the socio-demographic characteristics between adolescents born premature compared to those who were not. Using Pearson's chi-square tests, children who were born premature and those who were not born premature were also compared by body weight. Specifically, four levels of BMI were examined between premature and non-premature participants. The dependent variable was dichotomized into of adequate weight and overweight, and the chi-square was rerun with the dichotomized variable. The influence of being born premature on the dependent variables was also assessed using logistic regression. More specifically, each of these regressions was run controlling for no demographics, controlling for all demographics, and controlling demographics and TV watching.

## MPH Competencies

Competencies in public health and health education are needed to successfully complete my Masters of Public Health coursework. This integrated learning experience addresses the following competencies: selecting quantitative and qualitative data collection methods for a given health context, analyzing quantitative and qualitative data using biostatistics, informatics, computer-based programming and software appropriately, identifying, developing and delivering a variety of communication strategies, methods and techniques, and last, interpret results of data analysis for public health research, policy or practice.

***Select quantitative and qualitative data collection methods appropriate for a given public health context.*** This integrated learning experience used quantitative data collected via telephone survey using an independent variable (prematurity) and a dependent variable (BMI). There were 39,834 participants. Children's age was chosen, so we chose to focus on older children to understand how prematurity affects children as they grown up. Sensitivity analyses were done by race/ethnicity given the racial/ethnic disparities that were discussed in the literature review.

***Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate***. Data analysis was conducted utilizing IBM SPSS 23.0. The Pearson's chi-square test and logistic regression were used in the analysis. The Pearson's Chi Square tests were used to examine the difference percentages between children born premature and those with higher body mass index (BMI). Logistic regression was used to examine the association between premature birth and obesity. Data were examined and interpreted in the result section.

***Identify, develop and deliver a variety of communication strategies, methods and techniques***

For this competency, I only identified communication, methods, and technique strategies. I did not develop and deliver any strategy methods or techniques. Literature was reviewed and identified to determine the best practices between the maternal mother and the healthcare provider to decrease preterm pregnancy outcomes. Based on the literature reviewed, an identified strategy used was a method called "catch up growth". Catch up growth, also known as feeding formula milk to preterm infants in massive amount. When utilizing this method "catch up growth" on preterm infants for nutritional treatment and weight gain the best methods and techniques suggested the use of breast milk instead of formula since breast milk has been proven to be healthier. Another identified strategy is to utilize the life course perspective for the

development of targeted interventions. This theory evaluates multiple stages of an individual life including factors leading up to the end of pregnancy. A specific recommendations is to communicate verbally preterm birth, and obesity preventive measures to the mother. To prevent preterm birth outcomes, the best practice is to promote and educate via videos, pamphlet, and literature during every visit on how to make good choices to eliminate the bad outcome such as not to smoke or drink while pregnant. Communicate with the mother on the importance of receiving regular checkups, and to also convey thoroughly with their health care provider. To address obesity prevention, the best strategy is to enhance parents to play a central role in their children lives to prevent childhood obesity. Specifically, parents set the stage for children's healthy lifestyle behaviors by fostering a supportive home environment, role-modeling health habits, and monitoring and reinforcing children's behavior (Avis, Cave, Donaldson, Ellendt, Holt, Jelinski, & Ball, 2015).

***Interpret results of data analysis for public health research, policy or practice.*** Once data was run, I had to interpret the results. The results revealed out of 39,834 ten to seventeen years old children in the sample were born premature. When various demographics were run data revealed more than half the sample of premature children were Caucasian, they lived in a single parent household, have public health insurance, and unemployed parents. The Pearson's Chi square test was used to examine relationships between premature births and BMI which revealed results being either underweight, overweight or obese in premature births. Logistic regression was used to compare the effects of prematurity on dichotomous variables controlling for various demographics. Results revealed an association between prematurity and dichotomous BMI in the uncontrolled model, however when controlling for demographics and TV watching dichotomous BMI did not make a difference by prematurity. Strategies to reduce the prevalence of preterm

birth have significant implications for future health and well-being of the children and their families.

## Results

Of the 39,834 ten to seventeen year old children in the sample, 4,226 (10.60%) were born premature. Half (55.9%) of the premature children were Caucasian (Table 3). However, the premature portion of the sample included a larger percentage of racial minorities than the sample as a whole, for example, Hispanics made up (15.8%), Black, non-Hispanic made up (18.1%), and multi-racial/other, non-Hispanic made up a total of (10.2%). Premature children were more likely to live in a single parent household making up (17.9%) of the sample than non-premature children who made up (15.1%). Premature children were also more likely to have public health insurance (37.9 %), and have unemployed parents (15.2%) than non-premature children (13.0%) in this sample (Table 3).

Chi square tests were used to examine the relationship between prematurity status and BMI (Table 2). Though the results only approached significance, participants tended to be underweight at (7.5%), overweight at (17.0%), or obese at (16.5%) if they were born premature (Table 4). However, the dichotomous variable was not significantly different by prematurity status, although a higher percentage of children born premature were either underweight or overweight (Table 4). Supplemental analyses were run to examine differences in birth weight by race (Table 5). Race significantly predicted both dichotomous BMI and categorical BMI. For example, dichotomous BMI for Hispanics birth weight made up (60.8%) healthy weight, and (39.2%) being overweight. For the categorical BMI birth weight Hispanics tended to be underweight at (5.2%), overweight at (18.4%), and obese at [20.8%] (Table 5).

Logistic regressions were used to compare the effects of prematurity on the dichotomous variable controlling for various demographics (Table 6). There tended to be an association between prematurity and dichotomous BMI in the uncontrolled model (p=0.093). When controlling for demographics and TV watching, dichotomous BMI did not differ significantly by prematurity [p=0.184] (Table 6).

## Discussion

### *Overview and Main Findings of this study*

In this nationally-representative study, (10.60%) of children aged 10 to 17 years were born premature. Premature birth was associated with poor health outcomes in adolescence. Half of the premature children were Caucasian. However, a larger percentage of premature children was of racial minorities than the sample as a whole. In addition, children who were born premature tended to have unemployed parents, live in single parent households, and receive public health insurance.

Though the results of the present study only approached significance, there were some differences in body weight percentages between premature and non-premature adolescents. More specifically, adolescents that were premature tended to have body weights other than the normal range (i.e. too high or too low). These results somewhat suggest that prematurity may play some role in physiological conditions such as weight. The Chi square test revealed differences in percentages where there tended to be a relationship between prematurity and obesity. One explanation for the lack of significance may be that the BMI variable in this study is categorical, reducing body weights into categories rather than treating weight a continuous variable. Though this categorization is important for understanding clinical distinctions between healthy and

unhealthy body weights, an examination of body weight categorized in different ways may be more likely to yield significant results.

**What is already known on this topic?**

Premature birth was not associated with increased morbidity obesity amongst newborn infants in this study, however there were some tendencies. There is no one singular cause associated with premature birth. However, multiple maternal biological factors have been shown to increase the likelihood that a premature birth will occur including but not limited to: vascular disease, inflammation, infection, pre-eclampsia, eclampsia, uterine over distention, and intrauterine growth restrictions. In addition, nutrients deficiencies, alcohol use, or smoking by the maternal mother also are risk factors which may result in preterm births.

Premature births have been associated with childhood obesity due to infancy weight gain in a timely manner. In order to grow at a rate close to babies who are carried full term, premature infants need to receive good nutrition. The weight gain technique programs the infant to eat more to compensate growth, and weight gain. Research show that childhood obesity has several adverse consequences on overall health and leads to premature mortality. Experts agree that clinical interventions to prevent some health conditions should begin in utero.

Prematurity and obesity has been associated with low socioeconomic status. Low socioeconomic status can be linked to poor health education, poor eating habits, limited exercise, and limited access to healthcare resources such as prenatal care. Prior research has suggested that certain unhealthy behaviors listed above, which are more prevalent in individuals with lower socioeconomic status, may be possibly linked between low status, preterm births, and obesity

later in life. It has been theorized that low socioeconomic status and racial discrimination may be linked to disproportionate number of African American women to experience preterm birth. Several mechanisms help explain how prematurity may lead to obesity later on in life. One major hypothesis which links preterm infants and obesity is the period of "catch up growth" fast weight gain that occurs after the child is born. Insulin resistance which is a factor contributing to Type II diabetes has also been linked with prematurity and obesity. And last a hypothesis that links the two condition is consumption of formula opposed to breast milk during early infancy. The intake of formula is common in preterm infants in order to facilitate catch up growth.

***Limitations of study***

Though the present study yields unique insights into the relationship between prematurity and body weight, the present study is not without limitations. Most notably, the variables used in this cross-sectional study limited our ability to make inferences about cause and effect. Though in an acceptable range, the response rate to the survey was relatively low. As was pointed out in the previous paragraph, a limitation of the present study is the use of categorical BMI variables. Another limitations of this study was the lack of variables that I would have liked to have in this study. For example, I would have liked to know if and how many children in this study were breastfed and the duration period. Diabetes is another variable that I would have like to have data on. I would want to know if the maternal mother had ever been diagnosed with diabetes prior to or during pregnancy. Last, I would have liked to have data on multiple behaviors such as drinking, drugs, and smoking consumption from the maternal mother. The variables listed above could influence and/or explain an association between premature birth and obesity.

***Comparison of Current Findings to Those of Prior Studies***

Prior studies have emphasized a need for better management of factors early in a child's life that may result in the later development of obesity and conditions associated with it. Based on the findings of their research, Casey et al. emphasize caution in regards to the nutritional treatment of newborns, particularly those expected to undergo a period of catch-up weight gain (Casey et al., 2012). Both Litvinchuk et al., and Zarrati et al., emphasize limiting the amount of formula fed to preterm infants and recommend the use of breast milk instead. Their findings show an association between proper breastfeeding duration, weaning, and reduced risk of later metabolic and cardiovascular issues (Litvinchuk et al., 2014; Zarrati et al., 2013). A 2007 study by Singhal and Lanigan theorized that based on biological factors breastmilk consumption, which is associated with slower growth rate, could potentially be counteracting the effect of the accelerated catch up growth that occurs in premature and low birth weight infants (Singhal & Lanigan, 2007). An earlier conducted systematic review of published evidence into the correlation between breastfeeding and obesity reduction did demonstrate a positive correlation, however collectively it showed only a small effect. Even though correlations directly with obesity are still a topic in need of more research, the other nutritional benefits of breast milk on an infant's development are not to be underscored (Owen, Martin, Whincup, Davey-Smith, Gillman, & Cook, 2005).

A review of multiple past studies noted that changes to physical activity patterns, and interventions targeting those areas, if implemented early in childhood have been shown to have positive effects on the reduction of obesity (Olstad & McCargar, 2009). A 2008 study conducted amongst seventy 4 to 7 year old children in New York, whose BMI was above the 75$^{th}$ percentile, analyzed the effects of reducing sedentary behavior associated with television and computer usage by 50%. The children included in the intervention group of this study were

shown to have significantly greater decreases in targeted sedentary behavior, energy intake, and zBMI scores, despite little differences in the change in physical activity itself between the two groups. The authors of this study, based on their results, emphasized the importance of overall energy intake as opposed to physical activity alone as a primary factor in obesity prevention (Epstein et al., 2008).

My finding tended to show a relationship between prematurity and obesity although the association did not reach statistical significance. The catch up growth method may be a reason in why preterm infants become obese during childhood, and adolescent years, in addition to developing adverse consequences such as cardiovascular issues later on in life. The findings of the current study suggest the need to initiate early interventions such as diet modification and diet regimen adjustments that have been proven to decrease metabolic and cardiovascular issues and insulin resistance later on in life. Hoffman et al., study revealed that preterm and low birth weight infants both had isolated reduction in insulin sensitivity, which may put the infant at risk for type 2 diabetes (Hoffman et al., 2004). Both Stettler et al., and Vasylyev et al., studies showed a positive association between birth weight and body weight in childhood (Stettler et al., 2002; Vasylyev et al., 2013). Litvinchuk et al., study suggested that there may be an increased risk of obesity early on in infancy among preterm children, however more research is needed due to the study unable to consider the whole spectrum of clinical data. Two out of the five studies listed above were national surveys,and the content was similar to this particular study (Stettler et al., 2002; Klebanor et al., 2014). These two particular studies evaluated if rapid weight gain in early infancy is linked with overweight children, and obesity in low birth weight infants. The other three studies used surveys that were conducted locally (Hofman et al., 2004; Litvinchuk et

al., 2014; Vasylyeva et al., 2013). Overall, my study "the relationship between premature birth and obesity among children aged 10 to 17 years in the U.S." adds to them all.

When evaluating poverty, ethnicity, and risk of obesity in low birth weight infants Klebanov et al., revealed BMI differences emerging early on in life due to poverty issues (2004). More research is needed on how poverty affects the relationships between prematurity and obesity.

***Value of the project to the Community of Interest***

The community can be defined as: medical providers taking care of pregnant women, mothers, and children. It can also be defined as the group of pregnant women, mothers, and children in the U.S.

Value of the project/implications for medical providers

There needs to be more research and practice on premature infants and obesity during childhood as well as adult obesity. As it was stated earlier in this paper, prematurity is the leading cause in infant mortality, and some studies show that obesity is secondary to preterm births due to aggressive nutrition for fast weight gain in infants.

Value of the project/implications for medical providers

Measures that should be taken at the doctor's office to prevent miscommunication would be to encourage the maternal mother to write down questions prior to first initial visit, and during each visit. All these questions should be answered. In addition, measures should decrease the likelihood of missed appointments by strategies such as giving patient a courtesy reminder call prior to appointments. During doctor visits the health care provider should build a trustful rapport with the maternal mother so that she feels comfortable expressing her concerns during each visit with him/her. Fostering a variety of healthy foods in moderation for the developing

child/adolescent during school hours, and implementing physical activity during school hours, and afterschool early on to prevent childhood obesity are needed. Healthcare workers must recognize the barriers imposed by social factors that lead to preterm births and obesity in children such as lack of health education, and health literacy issues. Miscommunication and misunderstanding between the maternal mother and the health care provider is huge barrier that affects the behavior and outcome of the mother, infant or child. At every doctor visit, educational pamphlets should be given to the mother on ways to prevent preterm births and obesity. There need to be options offered by the health care provider such as encouraging the maternal mother to feed the preterm infant breast milk since studies prove this to be the healthiest and most nutritious meal for babies. Such measures taken will improve personal health choices, and produce healthy outcomes.

Value of the project/implications for pregnant women, mothers, and children

In order to both reduce the number of premature births and to decrease the detrimental health outcomes associated with premature birth, I recommend utilizing the life-course perspective for the development of targeted interventions. The life course perspective considers birth outcomes to be the result not only of the pregnancy itself but also the result of factors in the life of the mother leading up to the end of the pregnancy (Braveman & Barclay, 2009). According to the principles of this perspective, an individual's health status across their entire lifetime, and even the health status of their children, can be influenced by experiences that occur early in life. The interventions that are being proposed, such as offering high quality programs modeled on the most effective early head start approaches, high quality child care, and support for parents (Braveman et al., 2009) based on the life course perspective, therefore will continue through multiple stages of an individual's life.

Other life course interventions that can be implemented to improve the gap of black and white population in birth outcomes. For example, remove racism, reduce poverty amongst black families, and repair the education gap between the two races. Another life course intervention would be to improve health care, increase availability to care, enhance the quality of prenatal care, and modify healthcare access over the life course for African American women. Studies show the majority of preterm birth rates occur among African American families. Healthy measures should be taken and options should be available to prevent secondary problems such as obesity forming later in life. For starts, enforce healthy lunch options, and add more exercise courses during school hours to all children. Also implement free after school exercise programs, and healthy cooking classes to all children and families to promote physical exercise and healthy eating habits. A review of multiple past studies noted that changes to physical activity patterns, and interventions targeting those areas, if implemented early in childhood have been shown to have positive effects on the reduction of obesity (Olstad & McCargar, 2009).

There is no simple solution to childhood obesity secondary to preterm births. Childhood obesity is a complex problem that should be addressed accordingly. Policy makers, state and local organizations, community leaders, schools, childcare and healthcare worker can get involved by creating a healthy environment that correlates with a healthy lifestyle. Intervention programs on physical activity, and healthy eating and living should be established early on in one's life so that obesity and other life threatening diseases does not develop early or later in life.

To prevent preterm births, and increase healthy outcomes, studies show a need for early assessment, continual prenatal care throughout the pregnancy term, nutritional guidance to the maternal mother, wellness education on partaking in healthy behaviors, and learning how to deal with the many stressors of life that the maternal mother has to face. When all these things are in

place it benefits both the maternal mother and her unborn fetus, and gives both a better quality life.

## Conclusion

Preterm birth is the leading cause of infant death in the United States. There have been many studies that associate preterm birth with childhood obesity. Preterm birth and childhood obesity are both important health issues across the globe. Effective strategies to prevent preterm birth are getting regular checkups, taking prenatal vitamins, communicating thoroughly with the health care provider, reducing stress, getting rest, and eliminating bad habits such as: smoking, drinking, and drugs could all improve the outcome of preterm births. Effective strategies to prevent childhood obesity, and obesity happening later in life is to foster healthy eating habits, implement daily physical activity, and diet regimen adjustment to prevent detrimental consequences happening later on in life such as: diabetes, cardiovascular problems, and hypertension. Although there have been improvements in treatment for infants born premature, however, more research is needed due to the lack of understanding on the cause, and how to prevent preterm births.

**Table 1.** Prior Studies associated with Low Birthweight, Obesity, and Insulin Resistance

| Author/Year | Purpose | Population | Findings | Limitations |
|---|---|---|---|---|
| Hofman, P., Reagan, F., Jackson, W., Jeffries, C., Knight, D., Robinson, E., Cutfield, W., (2004) | Hypothesized study on preterm infants or gestational age infants that are small would be insulin resistance, a marker of type 2 diabetes | 72 children<br>Aged 4-10<br>50 (preterm/small for gestational age)<br>12 (low birth weight) | Preterm/small for gestational age and low birth weight infants both had isolated reduction in insulin sensitivity, may be a risk for type 2 diabetes | Small sample size due to invasive nature of testing procedure |
| Stettler, N., Zemel, B. S., & Stallings, V. A. (2002) | Cohort study to determine if rapid weight gain in early infancy is linked with overweight children | 27,899 participants | This study showed that the participants who showed the most rapid weight gain at 4 months of life were associated with overweight children | Not all children accounted for during study completed all measurements. Loss to follow up created a biased assessment amongst early rapid weight gain and obesity |
| Litvinchuk, T., Singh, R., Sheehan, C., Vasylyeva, T., (2014) | Examine early weight gain among preterm infants who later became obese | 37 preterm infants<br>27 (normal weight)<br>10 (obese) | Study showed an increase risk of obesity could be identified early on in infancy among preterm children | Due to a retrospective study they were unable to consider the whole spectrum of clinical data such as detailed nutrition and NICU care |
| Klebanov, P. K., Evans, G. W., & Brooks-Gunn, J. (2014). | Evaluating poverty, ethnicity, and risk of obesity in low birth weight infants | 985 participants | BMI differences emerged early on in life due to poverty issues. | More research is needed on differences of linked factors |
| Vasylyeva, T. L., Barche, A., Chennasamudram, S.P., Sheehan, C., Singh, R., & Okogbo, M.E. (2013) | Retrospective review conducted to determine the association risk of being obese during childhood and adolescent period in preterm infants | 160 preterm cases | Strong positive association between birth weight and body weight in childhood | none |

**Table 2.** Survey questions for variables included in this study

| |
|---|
| **INDEPENDENT VARIABLE** |
| **Was selected child born prematurely, that is, more than 3 weeks before [his/her] due date?** |
| Yes; No |
| What was [CHILD'S NAME] birth weight? |
| **DEPENDENT VARIABLES** |
| How much does [CHILD'S NAME] weigh now? |
| Adequate weight (85$^{th}$ percentile or lower) |
| Overweight (above 85$^{th}$ percentile) |
| **SOCIO-DEMOGRAPHIC VARIABLES** |
| **Age** |
| The child's age in years at interview<br>10-17 years (only 6-17 years included in this study) |
| **Gender** |
| Child's sex<br>Female; Male |
| **Race/ethnicity** |
| Hispanic; White, non-Hispanic; Black, non-Hispanic; Multi-racial/Other, non-Hispanic |
| **Relation to respondent** |
| What is your relationship to the selected child?<br>Maternal; Paternal |
| **Number of adults in household** |
| How many adults live in this household: 1; 2; 3+ |
| **Primary language** |
| What is the primary language spoken in your home?<br>English; Language other than English |
| **Healthcare coverage** |
| Does selected child have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or governmental plans such as Medicaid? Yes; No<br>Is that coverage Medicaid or the Children's Health Insurance Program, CHIP? Yes; No |
| **Employment status** |
| Was anyone in the household employed at least 50 weeks out of the past 52 weeks? Yes; No |
| **Child living in a working poor household** |
| How many children live in working poor households-parents employed full-time with income less than 100% FPL<br>Does not live in working poor household; Lives in working poor household |

**Table 3** Socio-demographics characteristics of children aged 10 to 17 years and by premature birth status, n=39,844

| Demographic Characteristic | All children: Weighted % in sample | Children not born premature: weighted % in sample | Children born premature: weighted % in sample | p-value* |
|---|---|---|---|---|
| **N (unweighted counts)** | 39,844 | 35,618 | 4,226 | |
| **Gender, %** | | | | 0.162 |
| Females | 48.8 | 49.1 | 46.6 | |
| Males | 51.2 | 50.9 | 53.4 | |
| **Race/Ethnicity, %** | | | | 0.016 |
| White, non-Hispanic | 58.3 | 58.6 | 55.9 | |
| Hispanic | 17.9 | 18.1 | 15.8 | |
| Black, non-Hispanic | 14.6 | 14.1 | 18.1 | |
| Multi-racial/Other, non-Hispanic | 9.2 | 9.1 | 10.2 | |
| **Relation of respondent, %** | | | | 0.751 |
| Maternal | 71.3 | 71.1 | 72.3 | |
| Paternal | 23.0 | 23.1 | 22.1 | |
| Other | 5.7 | 5.8 | 5.6 | |
| **Number of Adults in Households, %** | | | | 0.008 |
| 1 | 15.4 | 15.1 | 17.9 | |
| 2 | 60.0 | 59.8 | 61.1 | |
| Greater or equal to 3 | 24.7 | 25.1 | 21.0 | |
| **Language, %** | | | | 0.188 |
| Primary Household Language is English | 91.0 | 90.8 | 92.7 | |
| Primary Household Language is other than English | 9.0 | 9.2 | 7.3 | |
| **Health care coverage present at time of survey, %** | | | | 0.001 |
| Private | 67.3 | 67.9 | 62.1 | |
| Public | 32.7 | 32.1 | 37.9 | |
| **Poverty, %**** | | | | 0.355 |
| Children who do not live in a working poor household | 90.0 | 90.2 | 89.1 | |
| Children who live in a working poor household | 10.0 | 9.8 | 10.9 | |
| **Employment, *** %** | | | | 0.064 |
| Employed | 86.7 | 87.0 | 84.8 | |
| Not employed | 13.3 | 13.0 | 15.2 | |
| | | | | |

*****Chi square test for independence between each socio-demographic variable and reported prematurity

**Poor children were those living in households where the total household income was less than 100% the federal poverty level.

***Children who lived in employed households were those where anyone in the household worked at least 50 weeks out of the past 52 weeks. Children who lived in unemployed households were those *where no one in the household worked at least 50 weeks out of the past 52 weeks.*

**Table 4** Conditions among children aged 10 to 17 years overall and by premature birth status, n=39,844

| Condition | All children: weighted % in sample | Children not born premature: weighted % in sample | Children born premature: weighted % in sample | p-value* |
|---|---|---|---|---|
| **N (unweighted counts)** | 39,844 | 35,618 | 4,226 | |
| **BMI** | | | | 0.093 |
| Healthy weight | 69.1 | 69.4 | 66.5 | |
| Overweight | 30.9 | 30.6 | 33.5 | |
| **BMI Classification for Child** | | | | 0.052 |
| Less than 5$^{th}$ Percentile | 5.8 | 5.6 | 7.5 | |
| 5$^{th}$ to 85$^{th}$ Percentile | 63.3 | 63.8 | 59.0 | |
| 85$^{th}$ to 95$^{th}$ Percentile | 15.7 | 15.5 | 17.0 | |
| 95$^{th}$ + Percentile | 15.2 | 15.1 | 16.5 | |

*Chi square test for independence between reported prematurity and each condition

**Table 5** Conditions among children aged 10 to 17 years overall and by race, n=39,844

| Condition | All Children | Hispanic | White, non-Hispanic | Black, non-Hispanic | Multi-racial | p-value* |
|---|---|---|---|---|---|---|
| **N (unweighted counts)** | 39,844 | 4006 | 28317 | 3752 | 3769 | |
| **BMI** | | | | | | <0.001 |
| Healthy weight | 69.1 | 60.8 | 73.9 | 58.7 | 71.2 | |
| Overweight | 30.9 | 39.2 | 26.1 | 42.3 | 28.8 | |
| **BMI Classification for Child** | | | | | | <0.001 |
| Less than 5$^{th}$ Percentile | 5.8 | 5.2 | 5.7 | 5.0 | 8.9 | |
| 5$^{th}$ to 85$^{th}$ Percentile | 63.3 | 55.6 | 68.2 | 53.7 | 62.2 | |
| 85$^{th}$ to 95$^{th}$ Percentile | 15.7 | 18.4 | 14.1 | 18.7 | 15.5 | |
| 95$^{th}$ + Percentile | 15.2 | 20.8 | 12.0 | 22.6 | 13.3 | |

*Chi square test for independence between reported prematurity and each condition

**Table 6** Odds of being obese (dichotomous BMI variable) if having reported premature birth status for all children aged 10 to 17, n=91,116

| Dependent variable (obesity) | Uncontrolled Model | | | *Controlling for TV Watching | | | *Not Controlling for TV Watching | | |
|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio (OR)* | 95th Confidence Interval (CI) | p-value | Odds Ratio (OR)* | 95th Confidence Interval (CI) | p-value | Odds Ratio (OR)* | 95th Confidence Interval (CI) | p-value |
| BMI | 0.88 | 0.75-1.02 | 0.093 | 0.90 | 0.77-1.05 | 0.184 | 0.90 | 0.77-1.05 | 0.176 |

*****Weighted logistic regression adjusted for gender, race/ethnicity, age, number of adults in the household, language spoken in the home, and living in a working poor household

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