Assessing the Social and Ecological Factors that Influence Childhood Overweight and Obesity

---

A dissertation

presented to

the faculty of the College of Public Health

East Tennessee State University

In partial fulfillment

of the requirements for the degree

Doctor of Public Health

---

by

Katie Callahan-Myrick

December 2014

Dr. Liang Wang, Committee Chair

Dr. Shimin Zheng, Committee Member

Dr. Deborah Slawson, Committee Member

Keywords: Childhood Overweight and Obesity, Family Environment, School Influence, Social Influence, Behavioral Risk Factors, Community Environment, Social Ecological Model

ABSTRACT
Assessing the Social and Ecological Factors that Influence Childhood Overweight and Obesity

by

Katie Callahan-Myrick

The prevalence of childhood overweight and obesity is increasing at an alarming rate in the United States. Currently more than 1 in 3 children aged 2-19 are overweight or obese. This is of major concern because childhood overweight and obesity leads to chronic conditions such as type II diabetes and tracks into adulthood, where more severe adverse health outcomes arise. In this study I used the premise of the social ecological model (SEM) to analyze the common levels that a child is exposed to daily; the intrapersonal level, the interpersonal level, the school level, and the community level to better understand what risk factors are significantly associated with child weight status. Data came from the 2012 National Survey of Children's Health (NSCH) (n=41,361). Frequencies and confidence intervals were used to describe risk factors at each level. Bivariate analyses were conducted between each risk factor and the outcome variable. Using all risk factors that were significantly associated with overweight and obesity in the bivariate analyses, multinomial logistic regressions were performed for each SEM level. The 4 SEM levels were then analyzed together using stagewise multinomial logistic regression. A significance level cutoff of 0.05 was applied to all analyses. Thirty-three percent of participants were overweight or obese. Child sex, race, age, child physical activity participation, mother's education and health, the child's family structure, the child's participation in extracurricular activities, frequency of family meals at home, safety and engagement in school, the number of amenities and the safety and support within their communities were found to be significantly associated with child weight status. The odds ratios of the covariates in the final stagewise model were similar to those in each individual model. Understanding both the risk factors associated with child overweight and obesity in each individual level and in the complete socio-ecological perspective is important when working toward more effective policy and program creation and the reduction of childhood obesity. Recognizing that all levels of a child's SEM influence his or her likelihood of being

overweight or obese can lead to more effective strategies that tackle multiple SEM levels collectively instead of each level independently.

DEDICATION

I dedicate this page to my incredible family. Without their patience, support, and unyielding belief in what I am capable of, this may have never reached its completion. Thank you for pushing me when I was stuck!

AKNOWLEDGEMENTS

I need to acknowledge and offer many thanks to my dissertation committee members, Dr. Wang, Dr. Zheng, and Dr. Slawson for their guidance, patience, and flexibility as I worked on this from 3 hours away. I truly appreciate all of the quick email replies, long distance phone conversations, and efforts made to have meetings within my not-so-flexible schedule. You all are incredibly great people, thank you so much!

TABLE OF CONTENTS

Page

ABSTRACT 2
DEDICATION 4
AKNOWLEDGEMENTS 5
LIST OF TABLES 10
LIST OF FIGURES 12
ACRONYMS AND ABBREVIATIONS 13
Chapter
1. INTRODUCTION 14
Significance 14
Study Purpose 15
Research Questions and Hypotheses 15
2. LITERATURE REVIEW 17
Childhood Overweight and Obesity in the United States 17
Measuring Childhood Overweight and Obesity 18
Health Concerns Related to Childhood Overweight and Obesity 19
An Ecological Approach to Childhood Overweight and Obesity 21
The Socio-Ecological Model 21
An Ecological View of Childhood Overweight and Obesity 23
Intrapersonal Level 24
Health behaviors 24
Nutrition and eating behaviors 24
Physical activity behaviors 25
Sedentary behaviors 26
Individual demographic characteristics 27
Child sex, age, race and ethnicity 28
Interpersonal Level 28
Family characteristics and health behaviors 28
Family structure 29

Parent health attitudes and knowledge 30
Parent health behaviors 30
Home environment 31
Home food environment 32
Extra-curricular activities 33
Family demographic characteristics 33
School Level 34
Education and learning environment 34
School food environment 35
Physical activity and physical education 35
Bullying and peer victimization 36
Community or Neighborhood Level 37
Physical or built environment 38
Social environment 39
Policy Level 39
Combining All Levels of the Socio-Ecological Model 41
Tackling Childhood Obesity 43
Examining Childhood Obesity Interventions 43
Home and Family Interventions 43
School-Based Interventions 44
Community-Based Interventions 44
Built environment interventions 44
Community engagement or community interventions 45
An Ecological Approach to Childhood Obesity Interventions 46
3. DESIGN AND METHODS 48
Data Source and Participants 48
Data Collection Methods 49
Study Variables 49
Dependent Variable 49
Childhood Overweight and Obesity Status 49
Independent Variables 50

Stage 1 – Intrapersonal Level ……50
Demographic characteristics ……50
Average days of physical activity per week ……50
Amount of time spent watching TV ……51
Stage 2 – Interpersonal Level ……51
Family structure ……51
Mother's overall health status ……52
Days of family meals together weekly ……52
TV in child's bedroom ……52
Participation in extracurricular activities ……52
Stage 3 – School Level ……53
School engagement ……53
Repeated grades in school ……53
Number of school days missed ……53
Child attends a safe school ……53
Stage 4 – Community Level ……54
Live in a safe community ……54
Live in supportive neighborhoods ……54
Neighborhoods with amenities ……55
Statistical Analysis ……55
4. RESULTS ……58
Intrapersonal Level ……59
Interpersonal Level ……63
School Level ……69
Community Level ……73
Combining all Levels ……77
5. DISCUSSION ……82
Intrapersonal Level ……82
Interpersonal Level ……83
School Level ……85
Community Level ……86

Combining all Levels 87
Strengths of the Study 88
Limitations of the Study 88
Future Uses and Public Health Impact 89
Conclusion.....90
REFERENCES 91
VITA 111

LIST OF TABLES

Table Page

1. Classification of BMI-for-Age and Sex of Children and Adolescents (ages 2-17) ……..19
2. Indicators Included at Each Level of the Stagewise Logistic Regression Analysis……..56
3. Descriptive Statistics of All Intrapersonal Level Risk Factors (n=45,309) ……59
4. Descriptive Statistics of All Intrapersonal Level Risk Factors by Overweight and Obesity (n=41,361) ……..60
5. Bivariate Analysis of All Intrapersonal Level Risk Factors with Overweight and Obesity (n=41,361)……..61
6. Multinomial Logistic Regression Analysis of All Intrapersonal Level Risk Factors Associated with Child Overweight and Obesity (n=36,866) ……..63
7. Descriptive Statistics of All Interpersonal Level Risk Factors (n=45,184) ……64
8. Descriptive Statistics of All Interpersonal Level Risk Factors by Overweight and Obesity (n=41,361)……..65
9. Bivariate Analysis of All Interpersonal Level Risk Factors by Overweight and Obesity (n=41,361)……66
10. Multinomial Logistic Regression Analysis of All Interpersonal Level Risk Factors Associated with Child Overweight and Obesity (n=36,689)……..68
11. Descriptive Statistics of All School Level Risk Factors (n=45,182) ……..69
12. Descriptive Statistics of All School Level Risk Factors by Weight Status (n=41,361)……70
13. Bivariate Analysis of All School Level Risk Factors by Weight Status (n=41,361)……..71
14. Multinomial Logistic Regression Analysis of All School Level Risk Factors Associated with Child Overweight and Obesity (n=35,779) ……..72
15. Descriptive Statistics of All Community Level Risk Factors (n=44,546) ……..74
16. Descriptive Statistics of All Community Level Risk Factors by Overweight and Obesity (n=41,361)……..75
17. Bivariate Analysis of All Community Level Risk Factors by Overweight and Obesity (n=41,361)……..76
18. Multinomial Logistic Regression Analysis of All Community Level Risk Factors

Associated with Child Overweight and Obesity (n=36,481)……77
19. Stagewise Multinomial Logistic Regression Adjusted Odds Ratios (95% CI) of SEM Level Risk Factors and Child Weight Status……80

LIST OF FIGURES

Figure Page

1. Socio-ecological model of childhood overweight and obesity……23

2. Socio-ecological model of childhood overweight and obesity with level specific indicators ……42

ACRONYMS AND ABBREVIATIONS

95% CI – 95% Confidence Interval

BMI – Body Mass Index

CDC – Centers for Disease Control and Prevention

Child or Adolescent – Used synonymously in this paper to represent those aged 10-17, unless specified otherwise

CVD – Cardiovascular Disease

DHHS – Department of Health and Human Services

MCH – Maternal and Child Health

MRI – Magnetic Resonance Imaging

MVPA – Moderate to Vigorous Physical Activity

NCHS – National Center for Health Statistics

NHANES – National Health and Nutrition Examination Surveillance

NSCH – National Survey of Children's Health

NSLP – National School Lunch Program

OR – Odds Ratio

SEM – Socio-Ecological Model

T2D – Type 2 Diabetes

TV – Television

UOR – Unadjusted Odds Ratio

U.S. – United States

USDA – United States Department of Agriculture

YMCA – Young Men's Christian Association

CHAPTER 1

INTRODUCTION

Childhood overweight and obesity is an ever-growing problem among children and adolescents in the United States. The development of poor health behaviors early in life can have long-term negative effects on child health. There are many external influences that affect a child's health behaviors and outcomes. Children, especially in their younger ages, are influenced most by the components of their immediate surroundings, usually their parents, peers, schools, and communities. These environments and exposures have the opportunity to shape child health behaviors. Although there have been many programs and research studies focused around reducing childhood overweight and obesity, very few have focused directly on all aspects of a child's ecological environment and which influences increase the likelihood of child overweight and obesity outcomes the greatest. The purpose of this study is to gain a better understanding of the ecological factors that are associated with childhood overweight and obesity and to assess where the greatest influences lie. The development of childhood overweight and obesity stems from multiple influences and exposures in a child's life. Understanding factors associated with childhood overweight and obesity using a more ecological approach can help us create more comprehensive and effective programming to combat and prevent this public health crisis.

Significance

In the United States (U.S.) 1/3 (31.8%) of children aged 2-19 are overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). Within the child and adolescent population the prevalence of overweight and obesity has been climbing at an alarming rate for 3 decades and continues to do so today (Centers for Disease Control and Prevention, 2014). This study is an analysis of the ecological factors and influences that are associated with overweight and obesity among children and adolescents using the 2011-2012 National Survey of Children's Health (NSCH). The NSCH is a nationally representative sample of child health behaviors and outcomes in the U.S. It provides an excellent source of social and

ecological risk factors that are common to today's children, including individual, parental, social, educational, and community factors. This abundance of variables associated with a child's common ecological influences allows for a multilevel assessment of childhood overweight and obesity. Identifying the interrelationships and effects of the multiple levels of exposures and influences on childhood overweight and obesity will help to shed light on the major influences at each environment a child is exposed to.

Study Purpose

1. To describe the history and trends of childhood overweight and obesity in the United States.
2. To separately explore each level of a child's ecology to better understand the factors that are associated with childhood overweight and obesity.
3. To examine and compare ecological exposures combined to better understand their influence on childhood overweight and obesity.

Research Questions and Hypotheses

Research questions are based on review of existing literature

1. What is the status of childhood overweight and obesity in the United States?

   Hypothesis 1: In the U.S. the prevalence of childhood overweight and obesity remain high in 2011-2012.
2. What social and ecological indicators influence the likelihood of child overweight and obesity the greatest at each individual level?

   Hypothesis 2a: At the Intrapersonal level demographic characteristics such as sex, race, and mother's education and behavioral risk factors such as amount of physical activity weekly and time spent watching TV are significantly associated with child weight status.

   Hypothesis 2b: At the Interpersonal level family characteristics such as family structure, mother's health, participation in outside activities, and number of meals together weekly are significantly associated with child weight status.

Hypothesis 2c: At the School level child engagement in school and whether the child is attending a safe school are associated with child weight status.

Hypothesis 2d: At the Community level whether the child lives in a neighborhood considered safe and supportive is significantly associated with child overweight and obesity.

3. When all levels are combined which level of a child's social ecological model has the greatest influence over the development of overweight and obesity in today's children?

   Hypothesis 3: The SEM level that has the strongest influence over child overweight and obesity is the intrapersonal level.

CHAPTER 2

LITERATURE REVIEW

Childhood Overweight and Obesity in the United States

In the United States (U.S.) childhood obesity has more than doubled in children and tripled in adolescents in the past 30 years (CDC, 2014). Most recent estimates have reported that 14.9% of children aged 2-19 are overweight and 16.9% are obese (Ogden et al., 2014). The prevalence of obesity is increasing in all pediatric age groups, in both sexes, and in various ethnic and racial groups (Hamid, Islam, & Chanraray, 2013). Experts contend that childhood obesity is the most critical public health threat facing children today (Gable, Chang, & Krull, 2007). It has reached epidemic proportions and has become the most prevalent chronic condition affecting the health of children and adolescents in the U.S. (Raychaudhuri & Sanyal, 2012).

Ultimately overweight and obesity is the result of an energy imbalance where too few calories are expended for the amount of calories consumed. This energy imbalance is often the primary focus of obesity research and interventions, but it is not the only component contributing to the current obesity epidemic (CDC, 2014). The causes for obesity are multifactorial but minimal physical activity, increased levels of sedentary time, and excess consumption of energy dense foods are the major individual lifestyle behaviors believed to be contributing to weight gain and likelihood of obesity in youth (Fuemmeler, Anderson, & Masse, 2011). Influencing these individual behaviors are the organizational, environmental, and political influences that act as a foundation for their initial development. Ultimately the epidemiology of obesity during childhood varies by age, gender, race, ethnicity, and other factors that children are exposed to in their daily lives (Hamid et al., 2013). In order to gain a complete understanding of childhood overweight and obesity and to work toward successfully addressing this public health crisis will require coordinated and collective efforts in multiple sectors and settings, including government, health care, schools, and communities, that influence the food and physical activity environments in which children live (Vine, Hargreaves, Briefel, & Orfield, 2013).

Measuring Childhood Overweight and Obesity

Obesity is defined as excess body fat (Nemiary, Shim, Mattox, & Holden, 2012). There are various noninvasive ways that fat can be estimated, such as underwater weighing, bioelectric impedance, using skin fold calipers, and body mass index (BMI) calculation. Among these noninvasive methods the most commonly used screening tool is the calculation of BMI, which is derived from the weight and height of an individual. However, BMI is only a proxy for adiposity in children and adults. There are other measurement options such as dual x-ray absorptiometry, air displacement plethysmography, and magnetic resonance imaging (MRI) that give more detailed information into fat deposition, These methods offer more information but are all much more expensive and somewhat invasive (Spruij-Metz, 2011). There has been some concern regarding the reliability of self-reported height and weight to capture BMI (Danubio, Miranda, Viniciguerra, Vecchi, & Rufo, 2007). Danubia et al. found that height was generally over-reported and weight was often under-reported. The findings of that study showed that using self-reported BMI in epidemiologic studies could result in an underestimated prevalence of BMI (Danubio et al., 2007). Inversely, Bowring et al. (2012) found that respondents who were asked to self-report their height and weight and were later measured by a researcher were found to be very accurate with their self-reported measurements. Although not without its technical limitations, BMI has been recommended as the most important single indicator of overweight and obesity in children outside of research settings. Adult BMI can be calculated by hand using the following formula:

$$BMI = 703 \times (\text{weight (lbs.)}/\text{height}^2\ (\text{in}^2)) \text{ or}$$

$$BMI = (\text{weight (Kgm)}/\text{height}^2\ (\text{cm}^2))$$

For children and adolescents BMI changes with normal longitudinal growth. To determine BMI in children, it must be adjusted for age and sex (Skinner & Skelton, 2014). In 2000 the CDC published age and gender specific BMI percentile growth curves for youth ages 2-20 years of age. These growth curves are based on nationally representative and ethnically diverse samples and have taken age as well as gender into account (Spruij-Metz, 2011). Child BMI is reported in percentiles, where overweight is considered to fall within the 85^{th} – 95^{th} percentiles, and obesity is the 95^{th} percentile and above (Hamid et al., 2013).

As children exit adolescence their body mass proportion evolves to mirror that of adults, and BMI calculation no longer needs to be adjusted for age and sex (Skinner & Skelton). The breakdown of the classification of BMI-for-age and sex of children and adolescents (ages 2-17) can be seen in Table 1.

Table 1.

Classification of BMI-for-Age and Sex of Children and Adolescents (ages 2-17)

Classification	Body Mass Index (kg/m^2)
Underweight	Below the 5^{th} percentile ranking
Normal or Recommended	≥ 5th and < 85^{th} percentile ranking
Overweight	≥ 85th and < 95^{th} percentile ranking
Obese	≥ the 95^{th} percentile ranking

CDC, 2014

Health Concerns Related to Childhood Overweight and Obesity

Childhood overweight and obesity is now among the most widespread medical problems affecting children and adolescents living in both developed and developing countries (Hamid et al., 2013). It is among the easiest medical conditions to recognize but the most difficult to treat (Hamid et al.). Being overweight or obese in childhood has become a major challenge for public health because comorbidities are now starting to emerge in younger ages (Glavin et al., 2014). Childhood obesity is accompanied by an increase in conditions that were in previous years unheard of among children (CDC, 2013). As a result the rates of obesity-related comorbidities among children are increasing along with the alarming rise in childhood overweight and obesity (Flynn, 2013). For example, type II diabetes (T2D) has increased substantially among children and adolescents and is

now nearly half of all new child diabetes cases (Reifsnider, Hargraves, Williams, & Cooks, 2010). This dramatic increase of T2D among children and adolescents is additionally concerning because of the poor treatment compliance exhibited by this population. This is leading to increased likelihood of nephropathy and retinopathy among the younger generation (Sabin & Shield, 2008). Children and adolescents who are overweight or obese are at a higher likelihood of having cardiovascular disease (CVD) risk factors, including higher cholesterol levels and blood pressure. In fact, one study using a sample of obese children aged 5-17 years found that 70% of them had at least one risk factor for CVD and 30% had two or more risk factors (Domingo & Scheimann, 2012). Overweight and obese children have been seen to be more likely to have bone and joint problems, sleep apnea, and develop prediabetes (CDC, 2014). Children with a higher BMI are also more likely than those with a normal or recommended BMI to have insulin resistance, asthma, and depression (Koletzko et al., 2009). Overall, obesity is a disease that affects nearly every organ system in the body and manifests into unpredictable chronic conditions and comorbidities (Domingo & Scheimann). The health concerns related to childhood overweight and obesity are not limited to physical conditions. Children who are overweight or obese also face an increased likelihood of social and psychological problems such as stigmatization and poor self-esteem (CDC, 2014). With this increase of early onset of chronic conditions associated with childhood overweight and obesity, children today may be the first in more than a century to live less healthy, and possibly even shorter, lives than their parents (Spruij-Metz, 2011).

Most chronic diseases associated with childhood overweight and obesity will develop over many years. This is because 70%-80% of overweight and obese children will remain overweight their entire lives (Schaub & Marian, 2011). One longitudinal study found that 77%-92% of obese teenagers remained obese in adulthood (Finkelstein, Graham, & Malhotra, 2014). In these situations the health conditions associated with childhood overweight and obesity continue into adulthood and become larger health issues such as heart disease, stroke, T2D, several types of cancer, osteoporosis, insulin resistance, hypertension, hyperlipidemia, liver and renal disease (CDC, 2014; Hamid et al., 2013). There is no doubt that the long-term effects of childhood overweight and obesity can be

devastating to adult health. In addition to the increased likelihood of adverse health outcomes as adults, those who were overweight or obese in childhood and adolescence also have an increased risk of premature mortality (Reilly & Kelly, 2011). One study followed-up with children who had T2D 15 years later and found that of the 79 children in the study, 9% had died, and 6% were on dialysis (Sabin & Shield, 2008). Also, two separate studies have found that adolescent obesity was significantly associated with increased risk of disability pension awarded in adult life (Reilly & Kelly). There is a mountain of undeniable evidence that warns of the many health risks associated with childhood overweight and obesity. This increasing trend of obesity needs to be halted in order to improve current and future health outcomes of the children and adolescents in the U.S.

An Ecological Approach to Childhood Overweight and Obesity

In order to fully understand childhood overweight and obesity the daily social and ecological influences that increase the risk of developing excess body fat must be fully understood. The Ecological Theory of health suggests that health emerges from the day-to-day interactions between people and their environments (Institute of Medicine, 2003). These interactions affect all individuals differently and guide the development of health beliefs and behaviors. Obesity, when considering the ecological theory, is conceptualized as being influenced by factors across multiple levels: individual and family characteristics as well as characteristics of the community and region (Hawkins, Cole, & Law, 2009). The primary foundation of the ecological theory is that human behavior cannot be understood without taking into consideration the context in which it occurs (Davison, Jurkowski, & Lawson, 2012). By understanding a child's ecological influences we can begin to identify the factors that are associated with the development of child health behaviors that lead to childhood overweight and obesity.

The Social-Ecological Model

In its simplest form the social-ecological model (SEM) is a graphic depiction of the ecological theory of a given health behavior or outcome. It shows how health and well-being of an individual is determined by multiple influences and by their interactions

(Institute of Medicine, 2003). It can provide a useful framework for achieving a better understanding of the many factors and barriers that impact health behaviors and outcomes, in this case childhood overweight and obesity (Townsend & Foster, 2011). The social-ecological model helps to direct attention to broader political and environmental factors that shape individual and interpersonal characteristics of a person (Langille & Rodgers, 2010). When considering the daily exposures that children face and how they will respond to each exposure, it can be anticipated that no two responses are going to be exactly the same. The SEM helps to illustrate these exposures and begins to create a more comprehensive understanding of the complex interplay between the many exposures that children are faced with daily and the influence that these exposures have on the development of health behaviors (Institute of Medicine). This is an example where the SEM offers great potential for answering the large and complicated questions about how to prevent childhood overweight and obesity and where the most potent intervention point might be (Lytle, 2009). By recognizing and targeting the influences in a child's daily environment that have the most impact on obesogenic behavior development, prevention and intervention efforts may have a more lasting, substantial effect.

The SEM that is most commonly used in the field of public health has four or five different levels that all influence health behavior in some manner (Institute of Medicine, 2003). First proposed by Brofenbrenner (1979), the SEM is depicted as behavior development embedded in multiple spheres of influence ranging from those that are most proximal to the child's experience, such as the family, to those that are more distal, such as policies in place at the state and federal level that individually influence developmental processes (Fiese & Jones, 2012). For this study the SEM that was used to better identify the levels of influence that impact children's behaviors was created with five different levels (Figure 1). The intrapersonal level, in the center, is most related to an individual's behaviors and health beliefs. It is the most personal level of the model. As the levels move away from the center they tend to become less of a direct influence on health behavior and begin to have a more indirect influence (Institute of Medicine). Although not all influences have an equal impact on a child's health behaviors and decisions, as you can see from the model, they are all connected to a child's overall overweight and obesity in some way.

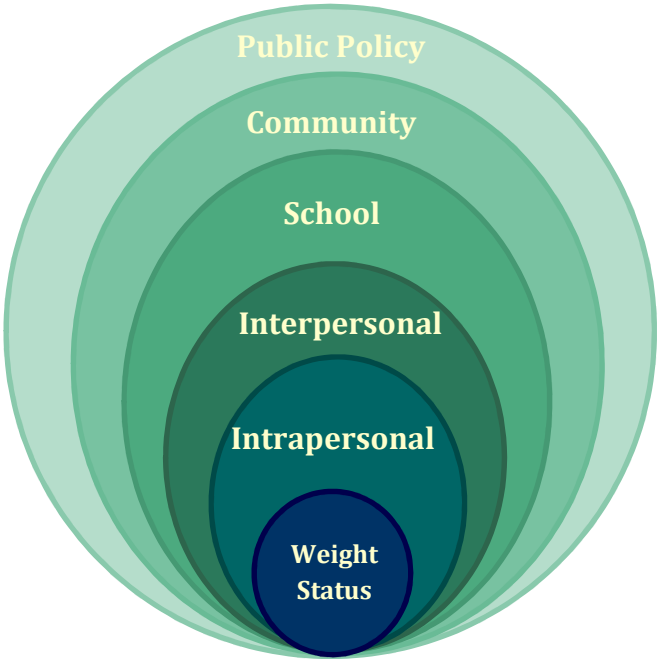

Figure 1. Social-ecological model of childhood overweight and obesity

Figure Adapted from: University of Victoria, Centre for Addictions Research of BC. *Theoretical Foundation; What is Health Promotion*. (2013). Retrieved February 18, 2014, from http://www.carbc.ca/KnowledgeinPractice/HealthyCommunities/BackgroundTheory.aspx

An Ecological View of Childhood Overweight and Obesity

An ecological view is a perspective that involves knowledge of the ecological model of determinants of health and an attempt to understand a specific problem or situation in terms of the model (Institute of Medicine, 2003). This perspective helps direct attention to broader political and environmental factors that shape individual and interpersonal characteristics within community and organizational settings (Langille & Rodgers, 2010). In order to fully capture an ecological view of child overweight and obesity in the U.S., it is important to describe the factors that influence a child's development of health behaviors and overweight and obesity status by the ecological level in which they most commonly exist for children. In the current research there have only been five other studies that have focused on assessing the risk factors associated with overweight and obesity by the different levels of the socio-ecological model. This is the first study to assess ages 10-17 at a population level.

Intrapersonal Level. The first level of the SEM is the intrapersonal level. It identifies the biological and personal history factors that increase the likelihood of becoming overweight or obese (Sarrafzadegan et al., 2013). These factors can include knowledge, attitudes, and behaviors related to diet, exercise, nutrition, and overall health in addition to age, race, and gender (Sarrafzadegan et al., 2013). This level of the ecological model is commonly the focus of child overweight and obesity research because the energy imbalance can be easily seen and analyzed (Fox, Dodd, Wilson, & Gleason, 2009). Overall, within the individual factors in this level is where we see the effects of all of a child's ecological influences (Dev, McBride, Fiese, Jones, & Cho, 2013).

Health behaviors. There is a clear connection between childhood overweight and obesity and the behaviors and health choices that children make on a daily basis. Understanding children's attitudes and behaviors is important in terms of child health outcomes (Scaglioni, Salvoni, & Galimberti, 2008). The behaviors that play a significant role in achieving and maintaining a healthy weight are nutrition and eating behaviors and physical activity and sedentary behaviors (Bauer, Berge, & Neumark-Sztainer, 2011).

***Nutrition and eating behaviors*.** Healthy eating is associated with reduced risk of many diseases including several leading causes of death such as CVD, cancer, stroke, and diabetes (Dietary Guidelines Advisory Committee, 2010). Healthy eating among children and adolescents is important for optimal growth and development and can prevent problems such as obesity, dental carries, iron deficiency, and osteoporosis (Dietary Guidelines Advisory Committee, 2010). Dietary Guidelines for Americans recommends a diet rich in fruits, vegetables, whole grains, and fat free and nonfat dairy products for persons aged 2 and older (United States Department of Agriculture (USDA), 2010). Proper nutrition can provide children with energy and strong, healthy bodies, prevent higher cholesterol and blood pressure levels, and decrease the risk of chronic disease such as CVD, T2D, and cancer (Dietary Guidelines Advisory Committee, 2010).

Obesity remains to be the most frequent nutritional disorder in childhood and adolescence, with diet being one of the most important precursors to overweight and obesity (Campbell et al., 2007). Research has consistently shown that the majority of

American children do not consume foods that meet the recommended Dietary Guidelines for Americans (Story, Nanney, & Schwartz, 2009). Instead, children are getting too few fruits and vegetables and too many foods that are high in sugar and fat but are nutrient poor (Leech, McNaughton, & Timperio, 2014). These dietary choices affect caloric intake and dietary patterns and promote specific behaviors such as increased consumption of fast food and sugar-sweetened beverages that have been linked with overweight and obesity (Lytle, 2009). Positive nutrition behaviors are of critical importance for growth, development, healthy body weight, and short- and long-term health outcomes among children and adolescents (Bruening et al., 2012). Nutrition behaviors and healthy food preferences are learned primarily by parents (Wyse, Campbell, Nathan, & Wolfenden, 2011). The foods that parents make available and the meals served have been shown to have a direct influence on child nutrition behaviors and preferences (Marviscin & Danford, 2013). Adequate consumption of fruits and vegetables provides the essential nutrients that children need is vital to maintaining a healthy balance of nutrition and calories and to aid in the prevention of overweight and obesity (Wyse et al., 2011). There are many factors such as food availability, parental eating habits, food preferences, and nutrition knowledge within the SEM that influence the foods that children choose to eat (Wyse et al., 2011). Understanding how these influences lead to the development of unfavorable nutrition behavior is integral in reversing such behaviors and working to promote healthier lifestyle choices.

Physical activity behaviors. The U.S. Department of Health and Human Services recommends that children aged 2-17 years participate in at least 60 minutes of moderate to vigorous physical activity (MVPA) daily (Fitzgerald, Fitzgerald, & Aherne, 2012). Regular physical activity helps to build healthy bones and muscles (Fitzgerald et al., 2012) and leads to an active lifestyle is likely to reduce many health problems. Physical activity has been associated with decreased BMI, and the prevention of developing CVD, T2D, obesity, and some cancers (Jago, Fox, Page, Brockman, & Thompson, 2010). In addition to the many health conditions that physical activity can prevent, it is also associated with numerous health benefits among children and adolescents. Physical activity is also positively associated with motor skill development, increased self-esteem scores and self-identity,

higher achievement in academics, increased concentration and attention, and decreased feelings of depression and anxiety (Carson, Rosu, & Janssen, 2014). Evidence indicates that physical activity can reduce the risk of childhood overweight and obesity, yet less than half (42%) of U.S. children aged 6-11 and only 6%-11% of children aged 12-15 engage in the recommended 60 or more minutes of MVPA daily (Carson et al., 2014; Dunton et al., 2012).

Physical activity behaviors have been found to be directly associated with childhood overweight and obesity in a number of studies. One longitudinal study of U.S. third grade students conducted by Anzman-Frasca et al. (2013) found that those who participated in after school recreational sports were less likely to be obese compared to their peers who did not participate in sports. This study also found that participating in after school sports was associated with a decreased risk of obesity among 10-17 year olds (Anzman-Frasca et al., 2013). Klakk et al. (2013) found that increasing the amount of physical education a child is required to participate in weekly results in decreased prevalence of child overweight and obesity.

Sedentary behaviors. Child and adolescent's lifestyles have become increasingly sedentary, with physical activity patterns having shifted from outdoor play to indoor entertainment such as TV viewing and playing computer games (Raychaudhuri & Sanyal, 2012). Sedentary behavior is characterized as any activity that requires very low energy expenditure and that occurs while sitting or reclining (Sigmund, Sigmundova, Hamrik, & Geckova, 2014). TV viewing has been reported as being the most common sedentary behavior among children and adolescents in the U.S. (Pearson, Salmon, Crawford, Campbell, & Timperio, 2011). Playing console games and watching TV have dramatically replaced physical activity and participation in organized sports (Tarro et al., 2014). The American Academy of Pediatrics recommends that children aged 2 years and older use screen time for no more than 2 hours per day (Schmidt et al., 2012). Most adolescents living in the Western countries spend more than the recommended 2 hours being sedentary, mainly in the form of screen time behaviors such as TV viewing, seated video gaming, and recreational computer use (Goldfield et al., 2011). In 2012 in the U.S. it was reported that

on an average weekday children and adolescents used screen media for about 7 hours per day, with children watching approximately 4.5 hours daily (Schmidt et al., 2012).

There is robust evidence that sedentary behaviors are linked to childhood overweight and obesity (Byrne, Cook, Skouteris, & Do, 2011). Sedentary behavior has been proven to be a contributor to the increased prevalence of childhood overweight and obesity (Mitchell, Pate, Beets, & Nader, 2013). Research has found that children who watched more than 2 hours of TV daily were twice as likely to be overweight compared to children who watched less than 1 hour of TV daily (Dubois et al., 2008). Also, those who watched more than 2 hours of TV daily had increased serum cholesterol levels and higher blood pressure compared to those who watched less than 1 hour of TV daily (Dubois et al., 2008). Mitchell et al. (2013) found that increased sedentary time was associated with higher BMI even among children who participated in the recommended amounts of MVPA daily. Much like childhood overweight and obesity, sedentary behaviors track into adulthood where they manifest into increased risk for morbidity and mortality (Goldfield et al., 2011). Added time participating in sedentary behaviors does not only negatively affect time spent participating in physical activity, it also has a detrimental effect on dietary intake and nutrition behaviors. Schmidt and colleagues (2012) found that children are more likely to eat while watching TV because satiety cues are often disrupted while viewing. It has also been found that watching TV is associated with eating more sweet, energy dense, snacks and sugar sweetened beverages (Jong et al., 2013). Dubois et al. found that children who ate snacks while watching TV had lower quality diets and higher BMIs. The effect of sedentary behaviors on the risk of child overweight and obesity appears to be one of dose-response, where an increase in time spent watching TV also leads to an increase in the risk of overweight and obesity (Schmidt et al., 2012). Understanding that increased time spent participating in sedentary behaviors such as watching TV and other screen time activities can lead to an increased risk of overweight and obesity and other related conditions can help to focus attention on the reduction in prevalence of childhood overweight and obesity by reducing time spent doing sedentary behaviors.

Individual demographic characteristics. In the U.S. the childhood obesity epidemic has become one of the main concerns about all children (Ogden et al., 2014).

Overweight and obesity status has been steadily increasing in girls and boys of all ages and ethnicities (Ogden et al., 2014). However, differences have been seen in the prevalence of overweight and obesity by sex, age, race and ethnicity. Specific population subgroups within the child and adolescent population are at an increased risk of becoming overweight or obese. This section provides examples of the disparities seen among overweight and obese children and adolescents.

Child sex, age, race and ethnicity. The risk of overweight and obesity varies across sex, age, and race. There have been considerable differences seen between ages, where preschool aged children (2-5 years old) have much lower prevalence rates of overweight and obesity compared to older children by ~10 percentage points (Wang, 2011). School-aged children (6-11 years old) and adolescents (12-19 years old) have been seen to have similar prevalence of overweight and obesity (Wang, 2011). National survey data have revealed large racial and ethnic disparities among childhood overweight and obesity. Non-Hispanic Asians (19.5%) and non-Hispanic Whites (28.5%) had the lowest prevalence of overweight and obesity (Ogden et al., 2014). Hispanics (38.9%) and non-Hispanic Blacks (35.2%) have a higher rate of overweight and obesity than other races (Ogden et al., 2014). Hispanic males (40.7%) and Hispanic females (37.0%) have the highest rate for overweight and obesity when combining all age groups, with non-Hispanic black females being a close second (36.1%) (Ogden et al., 2014).

Interpersonal Level. The interpersonal level examines the close relationships and influences that may directly affect the health behaviors that a child develops. These health behaviors often lead to an increased risk of becoming overweight or obese (Fuemmeler et al., 2011). The people and environment in this level of the SEM tend to hold great importance to a child's life. A child's family members, home environment, and closest social circle of peers influence his or her individual behaviors (Institute of Medicine, 2003). The influences found at this level are those that children are usually surrounded by as they grow.

Family characteristics and health behaviors. Family environment and characteristics exert important influences on development and shaping children's health behaviors and overweight and obesity (Lazarou, Kalvana, & Matalas, 2008.), especially in the early years (Scaglioni et al., 2008). Parents are the key to developing a home environment that fosters healthful eating and physical activity among children and adolescents. They influence a child's dietary practices, physical activity, and sedentary behaviors (Lindsay et al, 2006). This parental influence on child eating and activity behavior is particularly critical when considering the rising prevalence of obesity in children (Marviscin & Danford, 2013). Integrated within the behaviors that parents help children develop are the household rules and expectations associated with them. Parents' rules regarding physical activity, sedentary behavior, family meals, and types of food available in the home are the primary foundation on which many child behaviors are built. Parents are role models to their children in the adoption and maintenance of health promoting behaviors such as food choices and physical activity (Formisano et al., 2013).

Family structure. In recent decades major changes have occurred in family structure in Western countries. Today it is common to have two parents working, where in the past one parent, usually the mother, would stay home and take care of the children and the home (Formisano et al., 2013). The percentage of families with a single parent in the household is also much higher than it used to be (Formisano et al., 2013). There has also been a change in the structure of the family, with grandparents and aunts and uncles as caregivers (Formisano et al., 2013).

The structure of the child's family can be very diverse from what was once the norm. The different aspects of family structure have been shown to influence the likelihood of a child becoming overweight or obese (Hunsberger, 2014). Within a family there are many different relationships such as parent-child relationships, marital relationships, and sibling-relationships that affect a child's behavior (Fiese & Jones, 2012). Research has shown that within different types of family relationships there are also different levels of risk for overweight and obesity and other associated comorbidities. Children who live with their grandparents or have a single parent have both been found to have higher BMIs than children with dual parents (Byrne et al., 2011; Formisano et al., 2013). Single-parent

families have also been found to eat fewer servings of fruits and vegetables (Byrne et al., 2011). Bramlett and Blumberg (2007) found that children in step, single mother, or grandparent families are more likely to have poorer health outcomes than those living with two biological parents. Evidence has shown that the role of family structure may be a vital component and factor to consider when understanding child's health behaviors and decisions. The basic makeup of a family provides the initial foundation that all other aspects of the family are built upon. It can influence parent attitudes, behaviors, support, the home environment, and ultimately the person that a child becomes.

Parent health attitudes and knowledge. Understanding the knowledge, attitudes, and beliefs of parents is important for planning appropriately to manage their children's weight (Sarrafzadegan et al., 2013). Parents' knowledge of nutrition, influence over food selection, home eating patterns, modeling of healthful eating, and level of physical activity and sedentary behavior, including TV viewing, are all influential in their children's lifelong habits (Lindsay et al, 2006). Parents who are more knowledgeable about nutrition are more likely to make healthy eating choices for their children (Sobol-Goldberg, Rabinowitz, & Gross, 2013). In fact, increased maternal knowledge has been found to be associated with healthier diets and lower body weight in children (Hendrie, Sohonpal, Lange, & Golley, 2013). When parents model healthy behaviors such as fruit and vegetable consumption, children will learn from them and mirror their behavior (Hendrie et al., 2013). Parents with lower education levels overall were found to have children with increased risk of overweight and obesity (Veldhuis et al., 2013).

Parental perceptions, attitudes, and beliefs are very important for the overall health status of the child (Sarrafzadegan et al., 2013). Parents greatly influence a child's food choices and eating environment and play an important role in obesity prevention (Marviscin & Danford, 2013; Raychaudhuri & Sanyal, 2012). The home environment is where a child first acquires health habits, and parents play a pivotal role in modeling, teaching and creating healthy lifestyles for children (Golan, 2006).

Parent health behavior. Much like childrens' individual behaviors can lead to an increased risk of overweight and obesity, so can the parents' health behaviors. Children are

more likely to learn behaviors related to energy intake and expenditure from their parents (Veldhuis et al., 2013). Parental lifestyle behaviors such as healthy food preferences and the amount of physical activity and sedentary behavior they participate in have been shown to be associated with childhood overweight and obesity (Veldhuis et al., 2013). Parents are role models for healthy behaviors and have a large influence on the development of a child's own behaviors (Formisano et al., 2013). Studies have shown that children's eating behavior is strongly influenced by parental behavior (Scaglioni et al., 2008) where parents who make healthier food choices have children who make healthier food choices (Wyse et al., 2011). Researchers have focused on parental feeding practices and mealtime behaviors such as number of family meals together in the home and food preferences of parents to help explain childhood overweight and obesity (Brown, Ogden, Vogele, & Gibson, 2008; Gruber & Haldeman, 2009). Parents also play an important role in teaching skills and beliefs that are associated with physical activity behaviors (Edwardson & Gorely, 2010). Parents can encourage children to be physically active by supporting activity, by participating in physical activity, and by role modeling positive physically active behaviors (Edwardson & Gorely, 2010). It is vital that parents take an active role in the amount of physical activity their child participates in. Finally, Parents have the ability to oversee and determine the amount of time their children spend participating in sedentary behaviors by creating household rules and acting as role models for their children (Jago et al., 2010). Much like physical activity, children's sedentary time has also been found to be correlated with that of their parents (Fuemmeler et al., 2011). Gubbels et al. (2011) found a positive association between parent and child sedentary time. More than half of children report that they have rules on TV watching hours, but only 20% of those children say parents enforce the rules 'most of the time' (Lindsay et al., 2006). An increased number of TVs are being found in the home and in children's bedrooms. The presence of a TV or other electronic device in a child's bedroom has been found to be associated with increased time spent watching TV and decreased parental monitoring and supervision of time spent participating in sedentary activities (Lindsay et al., 2006).

Home environment. The family environment exerts important influences on the development and shaping of young children's eating and overweight and obesity as well as

their physical activity and sedentary behaviors (Lazarou et al., 2008). The behaviors, food options, and health related rules that parents establish for their children have been shown to predict health behaviors that children will develop (Formisano et al., 2013). Parents have the opportunity to raise their children in environments that fosters the development of health promoting behaviors (Scaglioni et al., 2008). The home environment is undoubtedly the most important setting in relation to shaping children's eating and physical activity behaviors because parental practices are key influences on the development of a child's own health practice (Golan, 2006).

Home food environment. Food is an integral part of family life and child development. From the moment a woman is pregnant the food environment plays an important role in the growth and development of her child (Fiese & Jones, 2012). It is composed of characteristics within the family that influence or shape children's dietary behaviors including various parental factors such as nutrition and health knowledge, parenting style, role modeling, food availability and access, as well as children's own individual characteristics and food practices (Hendrie et al., 2013). The food environment that parents provide for their children makes up the first foods children are exposed to (Scaglioni et al., 2008). Parents can encourage healthy eating by increasing the number of meals spent together, making healthy foods available in the house, and by decreasing the availability of sugar sweetened beverages and soda (Lindsay et al, 2006). Parents who make unhealthy energy dense foods more available at home are potentially creating obesogenic environments for their children. Obesogenic environments are characterized by the availability of large portions of inexpensive energy dense foods (Birch & Ventura, 2009). The frequent availability and access to such foods may lead to children developing preferences for unhealthier food items compared to more nutritional food options.

In addition to food availability, meal structure is also a part of the home food environment. Family mealtimes play an important role in promoting positive dietary intake among children and adolescents (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). Eating together as a family often proves to be a challenge with the increase of families that have two working parents and the demands of school and extracurricular activities.

However, eating together as a family has been shown to be beneficial to children's overweight and obesity (Neumark-Sztainer et al., 2003). Frequency of family dinners has been shown to be positively correlated with fruit and vegetable intake and negatively correlated with soda intake (Neumark-Sztainer et al., 2003). A growing body of research suggests that adolescents and youth who frequently share mealtimes with their families have diets of higher nutritional quality (Larsonet al., 2013). The increased nutritional value associated with family meals may help the achievement and maintenance of healthier weight in children and adolescents (Larson et al., 2013).

Extracurricular activities. Extracurricular activities are a means of keeping youth involved in activities outside of school (Elkins, Cohen, Koralewicz, & Taylor, 2004). These programs can be an ideal setting for promoting physical activity and healthy eating (Zarrett & Bell, 2014). They may also reduce the amount of time children would otherwise spend watching TV, playing video games, and participating in other sedentary activities (Elkins et al., 2004). The most common form of extracurricular activity is participation in recreational league sports teams such as basketball, baseball, softball, soccer, and cheerleading (Zarrett & Bell, 2014). These activities are inherently active and can increase the amount of time children spend participating in physical activity weekly. Other extracurricular activities such as special interest clubs can also promote physical recreation and healthier environments compared to the potentially sedentary home environment (Zarrett & Bell, 2014). Elkins et al. found a strong association between participation in extracurricular activities and Child BMI. Extracurricular activities allow children additional opportunities for physical activities and socialization with their peers. Both of these aspects have been shown to have a significant association with decreased BMI among children and adolescents (Elkins et al., 2004).

Family demographic characteristics. Certain parent and family demographics have been demonstrated to have different influences on childhood overweight and obesity risk. The predominant parental and familial demographic characteristics that are addressed in this research are household income and parent educational attainment. Household income, or socioeconomic status, has been found to be inversely associated with

obesity (Semmler et al., 2009), where an increased burden of childhood obesity is distributed among children in low income families (Davison, Jurkowski, Kaigang, Kranz, & Lawson, 2013; Tovar et al., 2012). Parents with lower education levels also have been found to have children with an increased risk of overweight and obesity (Veldhuis et al., 2013). Health knowledge, specifically, has also been shown to play a role in influencing childhood overweight and obesity. Parents with lowered knowledge regarding health were found to be significantly more likely to feed their children foods that were unhealthy and to report longer TV watching by their infants (Yin et al., 2014).

School Level. Schools are an important aspect of childhood life. In the U.S. more than 95% of young people are enrolled in school (CDC, 2013). Students attend school for 6 or more hours per day, 180 days per year, from ages 5-17 (Fox et al., 2009). No other institution has the same continuous contact with children during the first 2 decades of a child's life (Story et al., 2009). School is a place where children learn, socialize with their peers, and grow into young adults. There are many factors associated with schools that affect the risk of a child becoming overweight or obese, from the physical environment and physical activity opportunities of the school grounds, to the food environment at the school, to the social environment (Lumeng et al., 2010).

Education and learning environment. Schools provide the opportunity for students to learn about and practice healthy eating and physical activity behaviors (CDC, 2014). The primary role of schools has always been to educate students in academics, civic values, and social responsibility that will help them reach their full potential (Story et al., 2009). More frequently they are being tasked with preventing childhood obesity as well (Telford et al., 2012). The common perception today is that health and education are considered to be intertwined (Story et al., 2009). Schools are inviting settings for the promotion of health behaviors in children and have been identified as ideal for teaching children how to maintain a healthy, active lifestyle (CDC, 2013; Harrison & Jones, 2011). Health education is often a separate course offered in middle school and/or high school that is designed to address health behaviors and attitudes (Telford et al., 2012), but lessons on health could be integrated into multiple aspects of the school curriculum. Math, science,

history, and social studies are all excellent platforms to include lessons, examples, or assignments with a health focus. With the increased pressure that is now placed on academics, health and physical education emphasis is decreasing, which is contributing to childhood weight gain (Raychaudhuri & Sanyal, 2012). Instead of removing health promoting programs in schools, they need to be reinvented to fit within the already overloaded academic requirements.

School food environment. Schools are in a unique position to promote healthy eating and help ensure that there is appropriate food and nutrient intake among students (CDC, 2014). They provide students with opportunities to consider an array of foods and beverages throughout the school day and enable them to learn about and practice healthy eating behaviors (CDC, 2014). Schools have the opportunity to influence the foods that children consume as a whole because children consume a large proportion of their daily calories (20%-50%) at school (Story et al., 2009).

Studies show that schools have been making some progress in improving school food and physical activity environments (Story et al., 2009). The National School Lunch Program (NSLP) is a federally assisted meal program that provides nutritionally balanced low-cost or free lunches to children each day (United States Department of Agriculture (USDA), 2014). The program was first established under the National School Lunch Act, signed by Harry Truman in 1946 (USDA, 2014). All meals provided through the School Breakfast and NSLP must be consistent with the Dietary Guidelines for Americans (USDA, 2014). In January 2012 the U.S. Department of Agriculture (USDA) issued new school meal nutrition standards for breakfast and lunch (Food Research and Action Center (FRAC), 2012). These standards increased the amount of fruits and vegetables served to children daily, emphasized whole grain-rich foods, and required that only lower fat and nonfat milk be made available. The new standards also limit calories and reduce saturated fat and sodium levels (FRAC, 2012; USDA, 2014). All schools in the U.S. were required to begin implementing the new standards in the 2012-2013 School Year (FRAC, 2012).

Physical activity and physical education. Schools can promote physical activity through recess, classroom-based physical activity, intramural physical activity clubs, and

physical education classes (CDC, 2014). In the past 2 decades there has been a significant decline in students enrolled in physical education classes (Scaglioni et al., 2008). Physical activity and physical education promotion in schools is a way to increase the time that children spend in physically active play and can help to create healthy lifetime physical activity behaviors (Telford et al., 2012). Creating environments that encourage and support physical activity offers the greatest potential for children to be more active (Raychaudhuri & Sanyal, 2012). A longitudinal study conducted by Telford et al. found that an appropriately administered and designed physical education program can produce benefits for elementary school children not only by attenuating increases in body fat that is typical of children in this age group, but also by enhancing numeracy development. Physical education has long been associated with increased physical activity and decreased body weight among children and adolescents (Drake et al., 2014). Evidence has shown that physical activity participation declines as children become adolescents, with girls engaging in less physical activity than boys (Fitzgerald et al., 2012). For many students who do not participate in sports or intramural physical activities physical education courses in school may be the only physical activity that they are exposed to.

Bullying and peer victimization. In addition to the health risks associated with overweight and obesity, youth also face widespread stigmatization because of their weight (Puhl & Luedicke, 2012). At least 1/3 of children have reported being the victim of some sort of bullying (Lumeng et al., 2010). As prevalence rates of overweight and obesity have gone up, so have rates of weight-based stigmatization and prejudice (Puhl & Luedicke, 2012). Weight-based peer victimization is unsolicited bullying and teasing as a result of being overweight or obese (Robinson, 2006). It is a frequent experience for children and adolescents who are overweight or obese (Puhl & Peterson, 2012). Students report that weight related bullying occurs more than bullying due to race, religion, disability, or any other reason (Puhl & Peterson, 2012). Overweight and obese youth report various forms of victimization from verbal, physical, and relational to cyber bullying (Puhl & Peterson, 2012). Parents of obese children rank bullying as their top health concern (Lumeng et al., 2010). Weight-based victimization poses serious consequences for emotional and physical

health of overweight and obese children and adolescents. Weight-based victimization can lead to decreased school performance and attendance. Overweight and obese children and adolescents report many more missed school days than the general student population (Daniels, 2008). This can be due to a number of reasons. Overweight and obese students tend to be affected by the comorbidities associated with being overweight such as asthma and type II diabetes and miss additional days due to illness (Taras & Potts-Datema, 2005). What may be more concerning is that children are also missing additional days of school because of the psychological challenges associated with the stigmatization and bullying they receive from their peers (Daniels, 2008). One study found that overweight and obese students were absent from school 20% more than their healthy weight peers. When asked why they had missed so many days of school, the primary responses given were focused around bullying from their peers not illness (Daniels, 2008). Research has shown that weight-based teasing and bullying from peers is associated with poorer classroom performance, increased school avoidance, and decreased achievement and academic competence in youth (Puhl & Luedicke, 2012).

Schools are excellent learning environments where children spend a large proportion of their time (Tarro et al., 2014). With the number of hours and years students spend in school, there is no doubt that schools can play a significant role in most children's lives. Children are exposed to food choices, physical activity options and education, and teachings on healthy behavior (Harrison & Jones, 2011). There are many positive and negative influences that students are exposed to in schools. Whether the influences that affect children at school are negative or positive, may ultimately have a hand in shaping children's health behavior (Harrison & Jones, 2011). Promoting and working toward more positive influences at school could help foster more positive health behavior adoption and/or change (Fox et al., 2009).

Community or neighborhood level. More recently prevalence of childhood obesity has led to questions about the influence of obesogenic environments on child health (Williams et al., 2014). The way that neighborhoods are designed, their proximity to schools, parks, walking paths, shopping centers, and safety are all determinants of whether

children are able and permitted by their parents to walk to destinations and play outdoors (Giles-Corti, Kelty, Zubrick, & Villanueva, 2009). The built environment of communities and neighborhoods has been changing. These changes have resulted in increased traffic and fast food locations and decreased space for recreation and safe sidewalks and have impacted children's physical activity, sedentary, and nutrition behaviors (Giles-Corti et al., 2009). To address childhood obesity specific community and neighborhood characteristics that influence children's health behavior must be explored.

Physical or built environment. As public health advocates seek ways to curb the rise in childhood obesity, they have given increased attention to the role of the built environment in promoting physical activity and healthy eating behaviors (Rundle et al., 2013). The neighborhood built environment is comprised of buildings, roads, open spaces, and sidewalks and can provide opportunities or barriers to health (Tappe, Glanz, Sallis, Zhou, & Saelens, 2013). Physical environmental features within neighborhoods may have an important influence on both children and their parents (Huybrechts et al., 2010). Although response to these environmental 'triggers' of obesity may vary among individuals, the rise in obesity suggests that these environmental factors are major drivers for childhood obesity in the U.S. (Kim et al., 2006). The environment can influence a child's health behaviors in many ways. Easy access to fast food or convenience stores can influence poor eating choices, whereas access to parks or facilities that promote physical activity, and stores that offer healthy foods can foster positive physical activity and nutrition behaviors (Kim et al., 2006). Crime and safety can also have an impact on the built environment of the community and a child's health behaviors. Environments that are not safe to walk or play in, and have no safe space for play or recreation can lead to increased sedentary behavior (Kim et al., 2006). An important factor of the built environment is access to parks and recreation (Potestio et al., 2009). Parks can offer physical activity opportunities for those who have access and use them. Having park or recreation access in close proximity to a child's home has been found to be positively associated with increased physical activity participation among children and adolescents (Rundle et al., 2013). Living near a park or playground has also been shown to be associated with decreased time spent participating in sedentary behavior and decreased consumption of unhealthy foods (Gose

et al., 2013). The physical environment can be helpful or harmful to a child's health by facilitating or hindering physical activity and healthy eating behaviors (Gose et al., 2013).

Social environment. The social component of the community or neighborhood is comprised of the subjective and descriptive norms and other social influences that make up that neighborhood or community (Huybrechts et al., 2010). The social environment of the community can have either a positive or negative influence on health behavior (Maynard et al., 2009). Communities found to have more social cohesion and support have been found to have a great positive impact on health and well-being of community members (Maynard et al.). Communities can provide an excellent level of support and motivation to be healthy and active (Ziebarth et al., 2012). Lower income communities often offer limited social opportunities because of the lack of safety and resources within those environments (Foster et al., 2013). Some communities find social support in places that connect them to their specific cultures. Ziebarth et al. found great success with an obesity intervention that was facilitated at a Hispanic Community Health Resource Center where education and health promotion were tailored to be culturally relevant to the community members. To others the social environment of a community is focused around, support, safety and trust between neighbors. Much like the built environment, crime and safety can also influence the social environment. Without the belief that children are safe to play outside in their own yards and other neighbors are watching out for the children, parents will be less likely to allow their children to engage in outdoor play (Kim et al., 2006).

Policy Level. To reverse the obesity epidemic numerous policy and environmental changes have been implemented to create healthier environments that promote energy balance for children (Brennan, Brownson, & Orleans, 2014). Since 2000 major U.S. research funders, public and private, have devoted increased funds and resources to research to discover effective, usable, sustainable, and cost-effective policy and environmental interventions that address the childhood overweight and obesity epidemic (Brennan et al., 2014). Policies and practices that have the potential to benefit children the most should focus on the availability of sugar sweetened beverages in public settings, food marketing

standards, child care and school policies, the role of health care providers, and agricultural policy (Davison et al., 2012).

Currently the majority of policies that are targeted at childhood overweight and obesity are focused around in-school consumption and wellness. At the federal level the requirement for wellness policies was established by the Child Nutrition and WIC reauthorization Act of 2004, then it was later strengthened with the Healthy, Hunger-Free Kids Act in 2010 (USDA, 2014). On February 26, 2014, the USDA Food and Nutrition Service proposed regulations for school wellness policies (USDA, 2014). With the new proposed regulations, the schools at minimum would include specific goals for physical education, nutrition education, and nutrition promotion as well as nutrition guidelines for all foods and beverages in the school and policies for food and beverage marketing (USDA, 2014). In addition to the physical activity and nutrition requirements, schools would also have to do annual reporting, assessment, updates, and monitoring of the policies once established (USDA, 2014).

In addition, many schools are individually creating policies aimed at the childhood obesity epidemic (Datar & Nicosia, 2012). A school wellness policy is a written document that guides educational agencies and school district's efforts to promote child health (USDA, 2014). Such policies are important in promoting student wellness, preventing and reducing childhood obesity, and providing assurance that school meal nutrition guidelines meet the minimum federal school meal standards (USDA, 2014). Changing the school food environments and other practices that lead to improved dietary behavior are a powerful strategy to reverse the childhood obesity epidemic (Briefel, Crepinsek, Cabili, Wilson, & Gleason, 2009). Removing sugar sweetened beverages from school stores and snack bars, improving à la carte choices, and decreasing the frequency of offering french fries have all been recognized as effective strategies to reduce consumption of nutrient low, energy dense foods by children (Briefel et al., 2009). One study that examined overweight and obesity trends following the introduction of state and district wide policy changes in schools in Los Angeles reported a significant decrease in the rate of overweight and obese status among fifth-graders (Chriqui, Pickel, & Story, 2014). Another study researched a school in Texas after the implementation of a competitive foods policy and saw a significant

reduction in energy consumption from sugar sweetened beverages and poor food choices (Chirqui et al., 2014).

All of this research suggests that 'on the books' laws are doing what they intended to do. They are reducing the in-school availability of unhealthy competitive foods and beverages and in-school consumption of such items (Chirqui et al., 2014). In this study we are unable to capture if and how any existing policies may affect the risk of childhood weight status. However, it can be an incredibly influential component to the types of food options children are exposed to while at school, and the types of nutrition behaviors that children adopt.

Combining all Levels of a Child's Socio-Ecological Model. Understanding the different exposures that are common to each of the levels of a child's SEM is important in fully addressing all of the various risk factors that influence childhood overweight and obesity. In this study we are also assessing a complete ecological viewpoint of a child's many exposures that impact their weight status. Because the ecological theory suggests that health emerges from day-to-day interactions between people and their environment (Institute of Medicine, 2003), it is important to view each level of the child's SEM all together to begin to understand how the exposures at each level could interact and influence each other (Leroux, Moore, & Dube, 2013). Figure 2 shows a more in-depth look at an SEM that could influence children's health behaviors and ultimately their weight status. The risk factors listed for each level in Figure 2 have been found to be significantly associated with child overweight and obesity in the literature, as mentioned in previous sections, and have been included in this study, with the exception of policy level risk factors. Creation of interventions and prevention programs for childhood overweight and obesity requires an understanding of the multiple factors that influence childhood overweight and obesity (Fiese & Jones, 2012).

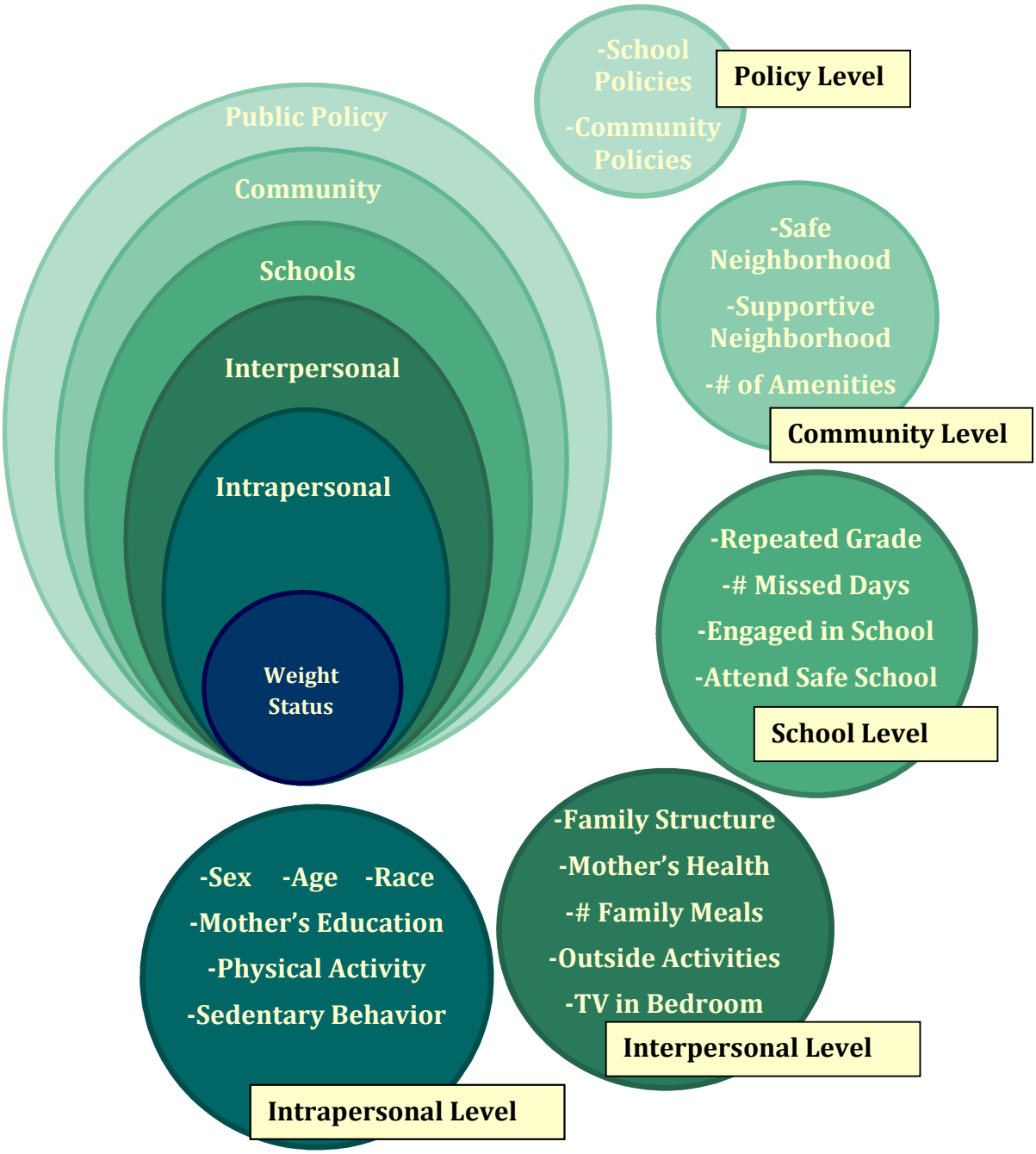

Figure 2. Socio-ecological model of childhood overweight and obesity with level specific indicators

Tackling Childhood Obesity

Childhood Obesity Interventions. Considering the many factors associated with childhood overweight and obesity, it is not surprising that its treatment is challenging (Kothandan, 2014). Countless numbers of interventions have been implemented to tackle the problem of childhood overweight and obesity in a variety of settings. Many interventions have focused on individual behavior change to prevent excessive child weight gain (Osei-Assibey et al., 2012). This strategy has generally lead to short-term improvements (Osei-Assibey et al., 2012), and so far, regardless of the intervention type, there has been unconvincing evidence of the longevity of intervention changes in child behavior change (Gonzales-Suarez, Worley, Grimmers-Somers, & Dones, 2009). Most interventions that have been conducted have focused primarily within one environment or one level of the social ecological model. This section briefly illustrates the successes and limitations observed within each intervention setting.

Home and Family Interventions. The primary challenge with family-based interventions is buy-in from parents and other family members. Family-based interventions are implemented on the premise that parental support, family functions, and the home environment are important determinants of treatment outcomes (Ebbeling, Pawlak, & Ludwig, 2002). Many of these interventions are focused around healthier meals and snacks in the home, limitation of TV or screen time, increased active playtime, and in some circumstances the removal of TVs and other electronic devices from children's bedrooms (Maynard et al., 2009; Schmidt et al., 2012). Family based interventions have been found to have strengths and weaknesses. Some interventions have been shown to positively change behavior, resulting in decreased screen time and increased time spent participating in physical activity and outdoor time among children (Lindsay et al, 2006). Some family-based interventions have also been found to be effective at decreasing the risk of childhood obesity (Ewald, Kirby, Rees, & Robertson, 2013). Other interventions, however, have been found to be ineffective at influencing behavior change or reducing overweight and obesity risk in children (Davison et al., 2013). Those failures have

commonly been attributed to challenges in reaching and engaging parents (Davison et al., 2013). The major challenge with this intervention type is keeping parents and families invested in changing their behaviors and helping their children's health outcomes.

School-Based Interventions. As obesity and related health conditions increase in childhood, schools are being seen as important locations for obesity interventions (Williams et al., 2013). The school environment is regarded as a good setting for health promotion interventions among school age children and offers many opportunities to develop strategies to prevent obesity (Brug et al., 2010). They provide a captive environment for 95% of children and adolescents in the U.S., where they can be reached repeatedly and continuously (Brug et al., 2010). Schools are also equipped with many of the needed resources that can aid in the development of positive health behavior such as gymnasiums, green space or space for playing, cafeterias and food options, and an environment that promotes learning (Branscum & Sharma, 2012). School interventions most commonly focus around three components; physical activity, nutrition, and education, and are all geared toward the development of positive individual health behaviors (Sobol-Goldberg et al., 2013). Some school-based interventions have tried to include all three components, food, physical activity, and education, to promote positive health behavior. One school removed the unhealthier meal items available to their students, added additional opportunities for physical activity in addition to physical education, and sent educational packets home to children (Lindsay et al., 2006). Both boys and girls who participated in this intervention group reduced their overweight and obesity status or the risk of becoming overweight (Lindsay et al., 2006).

Community-Based Interventions

Built environment interventions. The built environment's role in fostering high-energy consumption and low energy expenditure has been the focus of many studies. Characteristics such as walkability of roads, decreased options for recreation, density of fast food restaurants and convenience stores, and lack of access to healthy food options can create opportunities that support inactivity and poor eating habits (He et al., 2012). There have been many studies that have addressed the neighborhood factors associated with

overweight and obesity. Evidence has shown that living within close proximity to convenience stores and fast food restaurants was associated with poor nutritional intake (He et al., 2012) and that obesity rates are positively associated with the density of neighborhood fast food restaurants (Gilliland et al., 2012). Conversely, Tappe et al. (2013) found that people who live in neighborhoods that had easily walkable streets participated in more physically active behavior than individuals who did not live in neighborhoods with streets that could be easily walked on. Although it has been well established that the built environment can negatively affect weight outcomes, limited interventions have been conducted. The reason for this is because changing the built environment is very costly and difficult, especially in well-established neighborhoods and cities with limited space (He et al., 2012).

Community engagement and community interventions. Community engagement (CE) is the process of working collaboratively with groups of people who are affiliated by geography, similar interests, or similar situations in regards to issues affecting their well-being (Reifsnider et al., 2010). CE has been used as an effective way to bring stakeholders from the community setting together to create a partnership for the prevention of childhood obesity (Reed, Viola, & Lynch, 2014). Community-based interventions for overweight youth are recommended to facilitate family access to health promotion opportunities and resources such as educational sessions and recreation center access (Oen & Stormark, 2013). Community interventions come in many forms and depend on the resources within each individual community. Some community interventions have held family workshops, after school dance programs, or employee wellness programs that are all targeted at preventing childhood overweight and obesity (Schmidt et al., 2012).

Much like other interventions, these types of community-based interventions have resulted in mixed successes and limitations. Some community-based interventions have seen a reduction in overweight and obesity by 6% in children (Swinburn et al., 2013), while others have seen a significant reduction in time spent watching TV (Schmidt et al., 2012). Other community-based interventions have seen limited long-term results and had great difficulty sustaining the intervention once initial funding was gone (Grow et al., 2014).

Ensuring that community members continue to participate in the intervention and have the resources that they need available to them are two of the major challenges faced with these types of interventions (Swinburn et al., 2013).

An Ecological Approach to Childhood Obesity Interventions. With the ever-increasing prevalence of childhood overweight and obesity, innovative approaches that address obesity are needed (Kim et al., 2006). Just as obesity is the result of the number of interrelated factors, its elimination will involve multi-faceted action based on an ecological approach to problem-solving (Minor, 2012). Achieving the goal of prevention and control of the childhood obesity epidemic will require an intervention that considers the impact of a child's intrapersonal, school, and community influences and addresses individual as well as group behavior change (Spruij-Metz, 2011). Researchers must understand the underpinnings of the ecological model in order to develop research or interventions that further explicate the pathways and interrelationships of the multiple determinants of childhood overweight and obesity (Institute of Medicine, 2003).

Current research suggests that an inter-disciplinary approach is needed to successfully address childhood obesity (Sharma, 2011). A successful program must be long-term and address many factors as well as settings (Reed et al., 2014). Failure rates for interventions that are implemented in a single setting are so high that evidence suggests that targeting individual health behavior change alone may not be an effective obesity prevention strategy (McVey et al., 2013). Recently successful interventions have not only included multiple levels of influence but have also included local and regional conditions, culture, and other important components of the community (Reifsnider et al., 2010). Today, intervention trends appear to include a greater emphasis on policies, systems, and environment changes over the traditional programmatic efforts and a focus on community and institutional approaches as opposed to individually aimed education and behavior change efforts (Reed et al., 2014). Future interventions, based upon gaps found in the literature, should focus more on innovative study designs and intervention approaches, with greater statistical power and more rigorous analytical approaches (Wang et al., 2013). Research continues to point to schools as a focal point, but it is now also extending to

include families and communities (Reed et al., 2014). The literature is sparse in interventions that take place in settings other than schools (Wang et al., 2013). The field needs more studies that test environment- and policy-based interventions (Wang et al., 2013). By using the social ecological framework to address and tackle childhood overweight and obesity, all factors that influence child health behaviors and ultimately lead to childhood overweight and obesity are addressed (Lytle, 2009). This approach helps to capture a complete picture of childhood overweight and obesity risk factors and integrate them into addressing the obesity epidemic (Dev et al., 2013).

CHAPTER 3

DESIGN AND METHODS

Data Source and Participants

The 2011-2012 National Survey of Children's Health (NSCH) is a cross-sectional, national telephone interview that is conducted by the CDC's National Center for Health Statistics (NCHS) with guidance and funding from the Bureau of Maternal and Child Health (MCH) (NCHS, 2013). The NSCH provides a broad range of information about the health and well-being of children aged 0-17 years in the U.S. (NCHS, 2013). The purpose of the NSCH is to establish national and state-level prevalence for a variety of physical and behavioral child health indicators in combination with information on the child's family context and neighborhood environment (NCHS, 2013). It is also designed to provide baseline estimates for federal and state MCH performance measures and objectives for Healthy People 2020, generate information about children, their neighborhoods, and their families to help guide policymakers, advocates, and researchers (NCHS, 2013).

Participants for the 2011-2012 survey were parents or caregivers who lived with children aged 0-17 who were randomly contacted by landline or cell phone and asked to participate in the survey. A total of 95,677 interviews were completed in 2011-2012, with an average of 1,876 conducted in each U.S. state. Eligibility requirements specified that the respondent needed to be age 18 or older and be the parent or caregiver of at least one child under the age of 17 who lived in the household (NCHS, 2013). Additional recruitment and methodological information for the 2011-2012 NCHS are described in detail on the study website (www.childhealthdata.org/learn/NSCH).

Exclusion criteria for this study were determined by the age in which height and weight were asked to parents of their children. In the 2011-2012 NSCH height and weight were asked only of children aged 10-17. All children in the study were removed from this study if they were under the age of 10 because their BMI's were unavailable for analyses. Also excluded from this study were all children that were 'underweight'. There was a small sample of children who were underweight in the sample (n= 2,503 (5.8%)). They were

removed instead of being collapsed into the 'recommended weight' category. After removing all children under the age of 10 and children who were 'underweight', there were 42,806 observations analyzed in this study.

Data Collection Methods

NSCH interviewers reached participants by landline and/or cellphone using an independent random-digit-dial sample of phone numbers (NCHS, 2013). Contacted households were screened for the presence of children, and one child was randomly selected from identified households with children to be the subject of the survey. The respondent was a parent or guardian in the household who was knowledgeable about the child's health. These respondents are referred to as ''parents'' throughout this report (Blumberg et al., 2013). Interviews were conducted in English, Spanish, and four Asian languages (Mandarin, Cantonese, Vietnamese, and Korean) (NCHS, 2013). The interview completion rate for the 2011-2012 NSCH was 54.1% for the landline respondents and 41.2% for the cell phone sample (NCHS, 2013).

Study Variables

For this study the outcome variable was child weight status. Exposure or independent variables were chosen to be specific for each of four different levels of the SEM that were discussed earlier in this research. The SEM levels of focus for this analysis were the intrapersonal, interpersonal, school, and community level. Table 2 shows each level of the SEM analyzed in this study and the exposure variables included in each level of analysis.

Dependent Variable

Childhood overweight and obesity status. The outcome of interest for this study is body mass index (BMI), which was used to determine a child's weight status. BMI was calculated from parent reported child height and weight using standardized procedures

that adjusted for child age and gender. BMI percentiles were calculated based upon CDC growth charts as underweight (less than 5th percentile), healthy weight (5th through 84th percentile), overweight (85th through 94th percentile), and obese (95th percentile or above) (Spruij-Metz, 2011). For this study the four BMI categories were collapsed into three categories; 'recommended weight', which included the 5th through 84th percentile, 'overweight', which included the 85th through 94th percentile, and 'obese', which included the 95th percentile or above. Children who were underweight were excluded in further analysis due to their small sample size (n=2,503, 5.8%). Childhood obesity status was the outcome of interest for each separate analysis.

Independent Variables

Stage 1 – Intrapersonal Level.

Demographic characteristics. Child race was reported by parents at the time of the interview. Three categories were used by the NSCH to define race: White, Black, and Other. Child age was reported in both months and years by parents but was later converted into years. This study included children aged 10-17 in this analysis because several of the indicators were asked only of parents of children who were aged 10-17, limiting analysis to that age range. Age was collapsed into two categories, ages 10 to <14 and ages ≥14-17. Child gender was reported by parents as male or female. Mother's education was used as a proxy for socioeconomic status. Education has often been an established alternative to household income to measure socioeconomic status on the premise that higher educations have been seen to make a higher income than families with lower educational attainment. Also, mother's education has been found to be significantly associated with healthier diets and lower body weight in children (Hendrie et al., 2013). Mother's education attainment in the NSCH was categorized as less than high school, high school graduate, and more than high school. These three categories were used in this analysis.

Average days of physical activity per week. In order to capture this indicator respondents were asked, 'how many days during the past week did your child exercise, play a sport, or participate in physical activity that made him or her sweat and breathe hard'. Parents' responses were then combined into four categories; 0 days, 1-3 days, 4-6

days, every day. The categories were then collapsed into 0-3 days and 4+ days per week. This variable was used to represent child physical activity behavior.

Amount of time spent watching TV. To determine the amount of time the child spent watching TV, parents were asked, 'on an average weekday how much time does child usually spend in front of a TV watching programs, videos, or playing video games'. Parents reported their answers in the form of minutes and hours, which were then put into four categories; none, 1 hour or less, more than 1 hour but less than 4 hours, and 4 hours or more. The four categories were then collapsed to make a binary variable that consisted of TV watching time of 1 hour or less and more than 1 hour. This was done to closely match the American Academy of Pediatrics recommendations that children and adolescents should watch no more than 2 hours of TV daily (Schmidt et al., 2012). The 1 hour per day was also chosen as a cut-off point because studies have demonstrated that children who watch more than 1 hour daily are at an increased likelihood for becoming overweight (Dubois et al., 2008). This variable was chosen to be the indicator for child sedentary behavior because TV viewing in the most common form of sedentary behavior among children and adolescents (Pearson et al., 2011).

Stage 2 – Interpersonal Level.

Family structure. The different aspects of family structure have been shown to influence the likelihood of a child becoming overweight or obese (Hunsberger, 2014). Children who live with their grandparents or have a single parent have both been found to have higher BMIs than children with dual parents (Byrne et al., 2011; Formisano et al., 2013). Bramlett and Blumberg (2007) found that children in step, single mother, or grandparent families are more likely to have poorer health outcomes than those living with two biological parents. In this study family structure was broken into two categories: '2-parent households' and 'other types of households'. '2-parent households' included biological parents, foster parents, and step parents, as long as there were 2 of them in the household where the child lived. Family structures that were included in the 'other types' category were single-parent households, households with grandparents acting as parents, and households with aunts and uncles acting as parents.

Mother's overall health status. This indicator was originally comprised of two indicators, mother's physical health and mother's mental health. Each indicator was composed of three categories; excellent or very good, good, and fair or poor. To create the overall health indicator, these two variables were combined to create one single variable with the same three categories; excellent or very good, good, and fair or poor. For the indicator to qualify as "excellent or very good", both responses from the physical and mental health indicators had to be either "excellent" or "very good". For the indicator to qualify as "good", at least one response had to be "good", with the other response being either "good" or "excellent or very good". If one of the responses was "fair" or "poor", then the health status did not qualify to be "excellent or very good" or "good" and was labeled as "fair or poor" for this indicator.

Days of family meals together weekly. Parents' responses for the number of days they had meals together as a family in the past week ranged from 0 days to 7 days. These responses were then combined into four categories; 0 days, 1-3 days, 4-6 days, and every day. In this study, the variable was further collapsed into two categories; 0-3 days, and 4-7 days. This indicator is used to represent family home food environment. Family mealtimes have been shown to play an important role in promoting positive nutrition behavior, and having four or more family meals per week have been found to be associated with a higher intake of healthy food options (Neumark-Stzainer et al., 2003).

TV in child's bedroom. This variable was a 'yes' or 'no' response to the question of whether the child had access to electronic devices in his or her bedroom. This was chosen as an exposure variable in the interpersonal level because an important component of the home environment is TV viewing rules and access where TV in a child's bedroom is associated with increased time spent watching TV (Tandon et al., 2012).

Participation in extracurricular activities. Extracurricular activities are a means of keeping youth involved in activities outside of school (Elkins, Cohen, Koralewicz, & Taylor, 2004). These programs can be an ideal setting for promoting physical activity and healthy eating (Zarrett & Bell, 2014) and may also reduce the amount of time children would otherwise spend watching TV, playing video games, and participating in other

sedentary activities (Elkins et al., 2004). In this study whether the child participated in activities outside of school was broken into 'yes' if the child did participate and 'no' if the child did not participate.

Stage 3 – School Level.

School engagement. This variable was a composition of two different questions regarding the child's interest in school. School engagement was measured according to whether school age children usually or always cared about doing well in school and if they did all of their required homework during the previous month. The responses to the two questions were then combined to create the engagement indicator. This indicator was originally created with three categories; the child was never, rarely, or sometimes engaged in school, usually engaged in school, or always engaged in school. For these research purposes the variable was used in a binary format where children were never, rarely, or sometimes engaged in school or usually or always engaged in school.

Repeated grades in school. Childhood overweight and obesity is often associated with lower intelligence quotients and academic attainment (Li et al., 2012). Lower academic attainment could lead to repeated grades in school. For this indicator parents were asked if since kindergarten their children had ever had to repeat any grades in school. This was a binary variable with a 'yes' or 'no' format.

Number of school days missed. The number of school days missed was asked of the past 12 months. Parents reported their responses as a number of days. The responses were originally put into four categories; 0 days, 1-5 days, 6-10 days, and 11 or more days. For this analysis the categories were collapsed into three categories of, '0 days missed', '1-5 days missed', and 'more than 5 days missed. Missed school days were included in this analysis because childhood overweight and obesity has been shown to be associated with increased absenteeism among children and adolescents (Pan et al., 2013).

Child attends a safe school. Whether or not the child's school was safe was the perception of the parent. The parent was asked, 'How often do you feel your child is safe at school'. Parents were given the option of four responses, never, sometimes, usually, and

always. The responses of 'usually' and 'always' were combined and the responses of 'sometimes' and 'never' were combined to create a binary variable.

Stage 4 – Community Level.

Live in a safe community. Environments that are considered safe allow for outdoor space where children can play and participate in physical activity and foster positive physical activity behaviors (Kim et al., 2006). This indicator captured how parents perceived the safety of their neighborhood. Parents reported their neighborhood as; never safe for children, sometimes safe for children, or usually or always safe for children. For this study it was important to distinguish clearly between neighborhoods that were commonly considered safe compared to neighborhoods that were just sometimes or rarely considered safe. The neighborhood indicator was collapsed into more specific categories of; never or sometimes safe for children and usually or always safe for children.

Live in supportive neighborhoods. Neighborhood support is composed of several contexts such as, neighborhood support, neighborhood cohesion, and social capital. This question is the combination of four different survey questions. These questions are, 'people in my neighborhood help each other out', 'we watch out for each other's children in this neighborhood', 'there are people I can count on in this neighborhood', and 'if my child were outside and got hurt or scared, there are adults nearby who I trust to help my child'. Respondents were asked if they (1) strongly disagree, (2) somewhat disagree, (3) somewhat agree, or (4) strongly agree to each question. The four questions were then combined to create this supportive neighborhoods indicator. To create the indicator item responses were assigned values (1-4, as seen above) and an average was calculated for eligible cases. The threshold for living in a supportive neighborhood was a mean score of 2.25 or higher, indicating that no more than one response was a 'disagree' option. This indicator has a binary format where the options are, 'yes', the child lives in a supportive neighborhood, or 'no', the child does not live in a supportive neighborhood. This indicator is important because communities that provide a lot of social support have been found to have a positive impact on health behavior and physical activity participation (Maynard et al., 2009).

Neighborhoods with amenities. This indicator counts how many of four amenities; sidewalks, parks, recreation centers, or libraries are present in the child's neighborhood. The final indicator reports how many amenities the child has in their neighborhood, from a range of zero amenities to four amenities. For this study, the four amenities were collapsed into a binary variable of '0-2 amenities' and '3-4 amenities'. This indicator was collapsed with these cut-offs because of the proportion of amenities in these data and because research has shown that the number of amenities that a child has access to can be a determinant of whether children are able to walk to destinations and play outdoors (Giles-Corti et al., 2009).

Statistical Analyses

Descriptive statistics were computed for all variables. Chi-square tests were used to assess group differences for categorical covariates. Bivariate analysis was used to evaluate individual associations between each independent variable and child weight status. Unadjusted odds ratios (UOR), 95% confidence intervals (95% CI), and p-values were reported for each bivariate analysis. An alpha level of 0.05 was applied to all analyses. The baseline category logit model and the proportional odds model are two of the most commonly used logistic regression models. To select an appropriate model the proportional odds assumption was tested first. Once the appropriate model was found, individual and stagewise logistic regression models were built. Individual logistic regression models were run for each of the four SEM levels, and stagewise logistic regression was performed to assess the combined influences of all SEM levels on a child's weight status. Adjusted odds ratios (AOR) and 95% CIs were calculated for each of the individual logistic regression models and for the stagewise logistic regression model at each level. The indicators included in each of the stages of the stagewise regression can be seen in Table 2. Each logistic regression model included all covariates with $p \leq 0.05$ in bivariate analysis, and covariates that presented significant group differences. To assess the potential confounding of variables, if the addition of a covariate changed the OR relating the exposure of interest to the outcome of interest in the bivariate analysis by

more than 10%, then that covariate was kept in the model regardless of if it was significant at a 0.05 level (Hernan, Hernandez-Diaz, Werler, & Mitchell, 2002). If addition of a covariate did not change the odds ratio relating the exposure of interest to the outcome of interest by more than 10% and that covariate was not significantly associated with the outcome, the covariate was removed from the model. If any measureable differences were seen between the unadjusted ORs and the model ORs, potential interactions were assessed to determine any significant relationships between covariates of interest (Hernan et al.). ORs and p-values were reported for the bivariate analysis and for individual and final stagewise logistic regression models.

Table 2.
Indicators Included at Each Level of the Stagewise Logistic Regression Analysis

Stage 1 Intrapersonal Level	Stage 2* Interpersonal Level	Stage 3** School Level	Stage 4*** Community Level
-Sex	-Family structure	- School engagement	- Safe community
-Age	- Mother's health	- Repeated grades	- # of amenities
-Race	- Extra activities	- # of missed days	- Supportive Community
-Mother's education	- TV in bedroom	- Safe school	
- Physical activity	- # of family meals		
- TV viewing time			

* *Includes all variables from Stage 1*
** *Includes all variables from Stage 1 and Stage 2*
*** *Includes all variables from Stage 1, Stage 2, and Stage 3*

When the stagewise logistic regression was completed, changes in associations and likelihood were compared to assess how the different indicators at each SEM level influenced the outcome. Amount of influence was determined for variables by odds ratio value, and by strength of p-value. Conclusions were then made based upon the significant

relationships observed at the different stages and in the final, combined, stage. All data analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

CHAPTER 4

RESULTS

Among 42,806 children, 12,788 (33.3%) were overweight or obese, with 6,495 (16.6%) being overweight, and 6,293 (16.7%) being obese (Table 3). The data were composed of a nearly equal proportion of males (51.0%) and females (49.0%), with males having a higher proportion of obesity (19.6%) than females (13.6%). Combined, 7,572 (37%) of all males and 5,216 (29.4%) of all females were overweight or obese. Middle school aged, 10-13 year olds (49.0%), and high school aged, 14-17 year olds (51.0%), were also distributed quite evenly. Increased prevalence of overweight and obesity was seen among children in the younger age group, where 7,202 (39.0%) of children aged 10-13 years were overweight or obese, compared to 5,586 (27.9%) of children aged 14-17 years. There was a larger proportion of children who were white (67.4%) compared to those who reported being black (15.4%) or another race (17.2%). Across race white children reported the lowest prevalence of both overweight (15.9%) and obese (14.4%) compared to black children (19.2% and 23.9%) and all other races (17.4% and 14.4%). A majority of the mothers (63.6%) reported having at least a high school education. Less than one third (27.4%) of children whose mothers had more than a high school education were overweight or obese compared to 41.1% of children whose mothers completed high school or less (Table 4). In the bivariate analysis, gender, race, age, and mother's education were all significantly associated with a child being overweight or obese. Males had higher odds of being both overweight (UOR 1.2 95% CI 1.1-1.4) and obese (UOR 1.6 95% CI 1.4-1.8) than females. Both black children (UOR 2.0 95% CI 1.7-2.4) and children of other races (UOR 1.4 95% CI 1.2-1.8) were more likely to be obese than white children. Children aged 10-13 had increased odds of being overweight (UOR 1.5 95% CI 1.3-1.7) and obese (UOR 1.9 95% CI 1.6-2.1) than children aged 14 -17 years old. Children whose mothers completed high school or less were 1.6 (95% CI 1.4-1.9) more likely be overweight and 2.3 (95% CI 2.0-2.6) times more likely to be obese compared to children whose mothers had who had more than a high school education (Table 5).

Intrapersonal Level

More than half of parents reported that their children spent 4-7 days weekly participating in physical activity (62.3%) and watching more than 1 hour of TV daily (89.3%) (Table 3). Children who participated in more days of physical activity weekly had a lower prevalence of overweight and obesity (31.2%) compared to those who participated in 3 or fewer days of physical activity weekly (36.9%). Children who spent less time watching TV daily had a larger percentage of overweight or obesity (38.2%), compared to children who spent more time watching TV daily (32.7%) (Table 4).

Table 3.
Descriptive Statistics of all Intrapersonal Level Risk Factors (n=42,806)

Characteristics	n (%)
Child Weight Status***	
Recommended Weight	28,573 (66.7)
Overweight	6,495 (16.6)
Obese	6,293 (16.7)
Child Sex***	
Male	22,219 (51.0)
Female	20,533 (49.0)
Child Race***	
White	31,611 (67.4)
Black	4,301 (15.4)
Other	5,870 (17.2)
Child Age***	
10-13 Years	20,096 (49.0)
14-17 Years	22,710 (51.0)
Mother's Highest Education***	
High School or less	10,294 (36.4)
More than HS	28,333 (63.6)
Days of Physical Activity***	
0 to 3 Days per Week	15,385 (37.7)
4 to 7 Days per Week	27,039 (62.3)
Time Spent Watching TV**	
< 1 Hours Daily	4,015 (10.7)
1+ Hours Daily	38,409 (89.3)

*p<.05, **p<.01, ***p<.0001

Table 4.
Descriptive Statistics of All Intrapersonal Level Risk Factors by Overweight and Obesity(n=41,361)

	Weight Status					
	Healthy Weight		Overweight		Obese	
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
Characteristics	28,573 (66.7)	65.7-67.8	6,495 (16.6)	15.8-17.5	6,293 (16.7)	15.8-17.5
Child Sex***						
Male	13,966 (63.0)	61.5-64.5	3,631 (17.4)	16.2-18.6	3,941 (19.6)	18.4-20.9
Female	14,607 (70.6)	69.1-72.2	2,864 (15.8)	14.6-17.0	2,352 (13.6)	12.4-14.8
Child Race***						
White	22,114 (69.8)	68.5-71.0	4,557 (15.9)	14.9-16.8	4,064 (14.4)	13.4-15.3
Black	2,327 (56.9)	50.4-59.7	797 (19.2)	16.9-21.5	1,047 (23.9)	21.5-26.4
Other	3,544 (63.6)	63.3-66.9	986 (17.4)	14.9-19.9	1,009 (19.0)	16.2-21.8
Child Age***						
10-13 Years	12,013 (61.0)	59.4-62.5	3,515 (18.5)	17.3-19.8	3,687 (20.5)	19.1-21.8
14-17 Years	16,560 (72.1)	70.7-73.6	2,980 (14.8)	13.6-15.9	2,606 (13.1)	12.0-14.2
Mother's Highest Education***						
High School or less	5,786 (57.9)	55.6-60.1	1,721 (19.2)	17.5-21.0	2,154 (22.9)	21.0-24.8
More than HS	20,391 (72.5)	71.3-73.7	4,034 (14.9)	14.0-15.9	3,287 (12.6)	11.6-13.5
Days of Physical Activity***						
0 to 3 Days per Week	9,614 (63.1)	61.3-64.9	2,386 (17.0)	15.6-18.4	2,720 (19.8)	18.3-21.4
4 to 7 Days per Week	18,745 (68.8)	67.5-70.1	4,067 (16.4)	15.4-17.5	3,517 (14.8)	13.7-15.8
Time Spent Watching TV**						
< 1 Hours Daily	2,369 (61.8)	58.2-65.4	610 (16.3)	13.7-18.8	812 (21.9)	18.8-25.1
1+ Hours Daily	25,990 (67.3)	66.2-68.4	5,843 (16.7)	15.8-17.6	5,425 (16.0)	15.1-16.9

*p<.05 **p<.01 ***p<.0001

In the bivariate analysis gender, race, age, and mother's education were all significantly associated with a child being overweight or obese. Males had higher odds of being both overweight (UOR 1.2 95% CI 1.1-1.4) and obese (UOR 1.6 95% CI 1.4-1.8) than females. Both black children (UOR 2.0 95% CI 1.7-2.4) and children of other races (UOR 1.4 95% CI 1.2-1.8) were more likely to be obese than white children. Children who were aged 10-13 had increased odds of being overweight (UOR 1.5 95% CI 1.3-1.7) and obese (UOR 1.9 95% CI 1.6-2.1) than children who were aged 14 -17 years old. Mothers who had a high school education or less were 1.6 (95% CI 1.4-1.9) more likely to have an overweight child and 2.3 (95% CI 2.0-2.6) times more likely to have an obese child compared to mothers who had more than a high school education. Children who participated in 0-3 days of physical activity weekly were significantly associated with increased odds of obesity (UOR 1.5 95% CI 1.3-1.7) but not of being overweight (P=.06) compared to children who were reported to participate in 4 or more days of physical activity weekly. An inverse relationship was seen among time spent watching TV daily and childhood overweight and obesity, where children who watched less than an hour of TV daily were 1.5 (95% CI 1.2-1.8) times more likely to be overweight or obese than those who watched more than 1 hour of TV daily (Table 5).

Table 5.
Bivariate Analysis of all Intrapersonal Level Risk Factors with Overweight and Obesity(n=41,361)

	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Characteristics	Unadjusted OR (95% CI)	Unadjusted OR (95% CI)
Child Sex***		
Male	1.2 (1.1-1.4)**	1.6 (1.4-1.8)***
Female	1.00[b]	1.00[b]
Child Race***		
White	1.00[b]	1.00[b]
Black	1.5 (1.3-1.8)***	2.0 (1.7-2.4)***
Other	1.2 (1.0-1.5)	1.4 (1.2-1.8)**
Child Age***		
10-13 Years	1.5 (1.3-1.7)***	1.9 (1.6-2.1)***
14-17 Years	1.00[b]	1.00[b]
Mother's Highest Education***		

Table 5 (continued)

High School or less	1.6 (1.4-1.9)***	2.3 (2.0-2.6)***
More than High School	1.00[b]	1.00[b]
Days of Physical Activity***		
0 to 3 Days per Week	1.1 (1.0-1.3)	1.5 (1.3-1.7)***
4 to 7 days per Week	1.00[b]	1.00[b]
Time Spent Watching TV**		
Less than 1 Hours Daily	1.1 (0.9-1.3)	1.5 (1.2-1.8)***
1 or More Hours Daily	1.00[b]	1.00[b]

1.00[b]: reference category

*p<.05 **p<.01 ***p<.0001

For the intrapersonal level multiple logistic regression analysis after adjusting for all covariates, sex, race, mothers' education, and the number of days a child's participates in physical activity weekly were all significantly associated with overweight and obesity in children. Males were significantly more likely than females to be overweight (OR 1.3 95% CI 1.1-1.4) and obese (OR 1.7 95% CI 1.5-2.0) compared to females. Younger children had a higher likelihood of being overweight (OR 1.6 95% CI 1.4-1.8) and obese (OR 2.0 95% CI 1.7-2.3) than older children. When looking at race black children had the highest likelihood of being overweight (OR 1.5 95% CI 1.3-1.8) and obese (OR 1.9 95% CI 1.6-2.3) compared to children who were white. Children whose mothers had a high school education or less were 1.6 (95% CI 1.4-1.8) times more likely to have children that were overweight and 2.2 (95% CI 1.9-2.5) times more likely to have children that were obese compared to mothers who had more than a high school education. Weekly physical activity participation of the child was also found to significantly influence a child's weight status. Children who participated in 3 days or fewer were 1.2 (95% CI 1.0-1.4) times more likely to be overweight and 1.4 (95% CI 1.2-1.7) times more likely to be obese than children who participated in 4 or more days of physical activity weekly. The amount of time spent watching TV daily was not significantly associated with overweight or obesity status in the multinomial logistic regression and was not included in the final intrapersonal level model (Table 6).

Table 6.
Multinomial Logistic Regression Analysis of All Intrapersonal Level Risk Factors Associated with Child Overweight and Obesity(n=36,866)

Characteristics	Overweight vs. Healthy Weight Adjusted OR (95% CI)	Obese vs. Healthy Weight Adjusted OR (95% CI)
Child Sex***		
Male	1.3 (1.1-1.4)**	1.7 (1.5-2.0)***
Female	1.00[b]	1.00[b]
Child Race***		
White	1.00[b]	1.00[b]
Black	1.5 (1.3-1.8)***	1.9 (1.6-2.3)***
Other	1.1 (0.9-1.3)	1.3 (1.0-1.6)*
Child Age***		
10-13 Years	1.6 (1.4-1.8)***	2.0 (1.7-2.3)***
14-17 Years	1.00[b]	1.00[b]
Mother's Highest Education***		
High School or less	1.6 (1.4-1.9)***	2.2 (1.9-2.5)***
More than High School	1.00[b]	1.00[b]
Days of Physical Activity***		
0 to 3 Days per Week	1.2 (1.0-1.4)*	1.4 (1.2-1.7)***
4 to 7 days per Week	1.00[b]	1.00[b]

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

Interpersonal Level

At the interpersonal level there were much fewer children living in homes with single mothers or other less traditional family constructs such as living with grandparents or relatives (28.3%) compared to children who lived in two-parent homes (71.7%) (Table7). Children who had families with two parents in the household had a lower percentage of overweight and obesity (30.2%) compared to children with single parents only or other types of family structures (40.8%). Half of parents reported that the child's mother's overall health was excellent or very good (54.0%), and nearly three quarters of all parents reported that children have family meals together at home 4-7 days per week (72.8%). A lower prevalence of children with mothers in very good or excellent physical

health were seen to be overweight and obese (27.0%) compared to children whose mothers' physical health was reported good or poor (39.8%). Families that had a fewer number of meals together weekly reported a lower percentage of children who were overweight and obese (30.2%) compared to families that eat more meals at home weekly (34.4%). The proportion of overweight and obese children who had TVs in their bedrooms (34.0%) compared to children who didn't have TVs in their bedrooms (32.1%) was very similar. Children who participated in extracurricular activities outside of school had a lower prevalence of overweight and obesity (31.1%) than those who did not participate in activities outside of school (44.4%) (Table 7, Table 8).

Table 7.
Descriptive Statistics of All Interpersonal Level Risk Factors (n= 42,806)

Characteristics	n (%)
Family Structure	
2 Parents	31,873 (71.7)
Other	10,457 (28.3)
Mother's Health	
Very Good or Exc.	22,730 (54.0)
Good or Poor	16,261 (46.0)
Days Have Family Meals Together	
0 to 3 Days Weekly	11,461 (27.2)
4 to 7 Days Weekly	31,224 (72.8)
Child Has TV in Bedroom	
Yes	26,159 (61.8)
No	16,620 (38.2)
Child Participates in Outside Activities	
Yes	37,138 (82.9)
No	5,659 (17.1)

*p<.05 **p<.01 ***p<.0001

Table 8.
Descriptive statistics of All Interpersonal Level Risk Factors by Overweight and Obesity(n=41,361)

	Weight Status					
	Healthy Weight		Overweight		Obese	
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
Characteristics	28,573 (66.7)	65.7-67.8	6,495 (16.6)	15.8-17.5	6,293 (16.7)	15.8-17.5
Family Structure***						
2 Parents	22,250 (69.8)	68.6-71.0	4,576 (15.8)	14.8-16.8	4,029 (14.4)	13.4-15.4
Other	6,048 (59.2)	57.1-61.3	1,842 (18.6)	17.0-20.2	2,184 (22.2)	20.5-24.0
Mother's Health***						
Very Good or Exc.	16,562 (73.0)	71.7-74.4	3,138 (14.9)	13.9-16.0	2,463 (12.0)	11.0-13.1
Good or Poor	9,807 (60.2)	58.4-61.9	2,665 (18.3)	16.8-19.7	3,068 (21.6)	20.2-23.1
Days Have Family Meals Together**						
0 to 3 Days Weekly	7,751 (69.8)	68.0-71.7	1,713 (15.9)	14.5-17.4	1,611 (14.2)	12.9-15.6
4 to 7 Days Weekly	20,752 (65.6)	64.3-66.9	4,766 (16.8)	15.8-17.8	4,664 (17.6)	16.5-18.7
Child Has TV in Bedroom						
Yes	17,005 (66.0)	64.7-67.4	4,135 (16.7)	15.7-17.7	4,217 (17.3)	16.2-18.4
No	11,547 (67.9)	66.1-69.6	2,356 (16.5)	15.1-17.9	2,075 (15.7)	14.2-17.1
Child Participates in Outside Activities***						
Yes	25,478 (68.9)	67.8-70.0	5,548 (16.3)	15.4-17.1	5,034 (14.9)	14.0-15.7
No	3,089 (55.6)	52.6-58.5	946 (18.4)	16.1-20.7	1,259 (26.0)	23.3-26.7

*p<.05 **p<.01 ***p<.0001

In the bivariate analysis family characteristics such as family structure, mother's physical health, and the number of family meals eaten together weekly were all significantly associated with childhood overweight and obesity (Table 7). Children who lived in families with a single parent or other nontraditional structure were at increased odds of being overweight (UOR 1.4 95% CI 1.2-1.6) or obese (UOR 1.8 95% CI 1.6-2.1) compared to children from families with two parents. Inversely, children who lived in families that had meals together fewer times per week were found to have lower odds of being obese (UOR 0.8 95% CI 0.7-0.9) than those who had four or more meals together weekly. Children with mothers who reported poor or good physical health were 1.5 (95% CI 1.3-1.7) times more likely to have children that were overweight and 2.2 (95% CI 1.9-2.5) times more likely to have children that were obese compared to mothers who reported both excellence and very good physical health. Children who did not participate in activities outside of school had significantly increased odds of being overweight (UOR 1.4 95% CI 1.2-1.7) and obese (UOR 2.2 95% CI 1.8-2.6) compared to children who did participate in activities outside of school. The presence of a TV in the child's bedroom was not significantly associated with overweight and obesity among children (Table 9).

Table 9.
Bivariate Analysis of All Interpersonal Level Risk Factors by Overweight and Obesity(n=41,361)

	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Characteristics	Unadjusted OR (95% CI)	Unadjusted OR (95% CI)
Family Structure***		
2 Parents in Household	1.00[b]	1.00[b]
Other	1.4 (1.2-1.6)***	1.8 (1.6-2.1)***
Mother's Health***		
Very Good or Excellent	1.00[b]	1.00[b]
Good or Poor	1.5 (1.3-1.7)***	2.2 (1.9-2.5)***
Days Have Family Meals Together**		
0 to 3 Days Weekly	0.9 (0.8-1.0)	0.8 (0.7-0.9)***
4 to 7 days Weekly	1.00[b]	1.00[b]
Child Has TV in Bedroom		
Yes	1.0 (0.9-1.2)	1.1 (1.0-1.3)
No	1.00[b]	1.00[b]
Child Participates in Outside Activities***		

Table 9 (continued)

Yes	1.00[b]	1.00[b]
No	1.4 (1.2-1.7)***	2.2 (1.8-2.6)***

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

The final logistic regression model of the interpersonal level included exposure variables that are common to a child's home and family life. After adjusting for all covariates in the model, sex, age, race, mother's education, if the child participates in activities outside of school and the child's family structure were both significantly associated with a child's overweight and obesity (Table 10). The covariates sex, age, race, and mother's education had the same likelihood association that was seen in the final logistic regression model of the intrapersonal level (Table 6). Children who lived in households with a single parent or other nontraditional family structure were 1.2 (95% CI 1.0-1.4) times more likely to be overweight and 1.5 (95% CI 1.2-1.7) times more likely to be obese than children who lived in households with two parents. Children with mothers who reported good or poor health were 1.3 (95% CI 1.2-1.6) times more likely to be overweight and 1.8 (95% CI 1.5-2.0) times more likely to be obese than those who reported having excellent or very good health. As the number of days that a child ate meals together with his or her family decreased, likelihood of obesity also decreased, where children who ate 0-3 meals together weekly were 0.8 times (95% CI 0.6-0.9) as likely to be obese than children who ate more family meals together weekly. Children who participated in activities outside of school had a lower likelihood of being overweight and obese. Children who did not participate in outside activities were 1.3 (95% CI 1.1-1.6) times more likely to be overweight and 1.7 (95% CI 1.4-2.0) times more likely to be obese than children who participated in outside activities (Table 10).

Table 10.
Multinomial Logistic Regression Analysis of All Interpersonal Level Risk Factors Associated with Child Overweight and Obesity(n=36,689)

Characteristics	Overweight vs. Healthy Weight Adjusted OR (95% CI)	Obese vs. Healthy Weight Adjusted OR (95% CI)
Child Sex***		
Male	1.3 (1.1-1.4)**	1.7 (1.5-2.0)***
Female	1.00[b]	1.00[b]
Child Race***		
White	1.00[b]	1.00[b]
Black	1.4 (1.2-1.7)**	1.7 (1.4-2.0)***
Other	1.1 (0.9-1.3)	1.3 (1.0-1.6)*
Child Age***		
10-13 Years	1.6 (1.4-1.8)***	1.9 (1.7-2.2)***
14-17 Years	1.00[b]	1.00[b]
Mother's Highest Education***		
High School or less	1.4 (1.2-1.7)***	1.8 (1.5-2.1)***
More than High School	1.00[b]	1.00[b]
Family Structure***		
2 Parents in Household	1.00[b]	1.00[b]
Other	1.2 (1.0-1.4)	1.4 (1.2-1.7)***
Mother's Health***		
Very Good or Excellent	1.00[b]	1.00[b]
Good or Poor	1.3 (1.2-1.6)***	1.8 (1.5-2.0)***
Days Have Family Meals Together**		
0 to 3 Days Weekly	1.0 (0.9-1.1)	0.8 (0.6-0.9)**
4 to 7 days Weekly	1.00[b]	1.00[b]
Child Participates in Outside Activities***		
Yes	1.00[b]	1.00[b]
No	1.3 (1.1-1.6)**	1.7 (1.4-2.0)***

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

School Level

At the school level 3,688 (10.9%) of all children were reported to have ever had to repeat a grade, 8,434 (18.8%) were reported to have missed more than 5 days of school in the past year, and 9,234 (22.1%) were described as never engaged or interested in school. Children who never repeated any grades (32.5%), who were usually or always engaged in school (31.7%), and who missed 5 days or fewer of school in the past year (33.3%) had a lower prevalence of overweight and obesity compared to those who repeated at least one grade in school (39.0%), who were never engaged in school (38.8%), and who missed more than 5 days of school in the past year (36.0%). Children were predominantly reported as attending schools that were safe with only 2,441 (8.5%) of parents answering that the children were never or sometimes safe while at school. Children who went to schools that were considered safer also had a lower prevalence of overweight and obesity (32.4%) compared to children who went to schools that were considered not as safe by parents (42.9%) (Table 11, Table 12).

Table 11.
Descriptive Statistics of All School Level Risk Factors (n=42,860)

Characteristics	n (%)
# of School Days Missed Past Year	
0 Days	8,762 (23.7)
1-5 Days	25,206 (57.5)
>5 Days	8,434 (18.8)
Child Repeated Grade	
Yes	3,688 (10.9)
No	38,998 (89.1)
Child is Engaged in School	
Yes	33,536 (77.9)
No	9,234 (22.1)
Child is Safe at School	
Yes	38,318 (91.5)
No	2,593 (8.5)

*p<.05 **p<.01 ***p<.0001

Table 12.
Descriptive Statistics of All School Level Risk Factors by Overweight and Obesity (n=41,361)

	Weight Status					
	Healthy Weight		Overweight		Obese	
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
Characteristics	28,573 (66.7)	65.7-67.8	6,495 (16.6)	15.8-17.5	6,293 (16.7)	15.8-17.5
Number of School Days Missed Past Year*						
0 Days	5,875 (66.6)	64.2-68.9	1,266 (16.6)	14.6-18.5	1,209 (16.9)	15.0-18.8
1-5 Days	17,187 (67.7)	66.3-69.1	3,829 (16.7)	15.6-17.8	3,421 (15.6)	14.5-16.8
>5 Days	5,286 (64.0)	61.6-66.3	1,330 (16.4)	14.6-18.1	1,596 (19.7)	17.7-21.6
Child Repeated Grade**						
Yes	2,106 (61.0)	57.6-64.3	630 (18.0)	15.2-20.7	798 (21.1)	18.5-23.7
No	26,407 (67.6)	66.4-68.7	5,841 (16.3)	15.5-17.2	5,474 (16.1)	15.2-17.0
Child is Engaged in School***						
Yes	22,987 (68.3)	67.1-69.5	4,945 (16.2)	15.3-17.3	4,446 (15.4)	14.5-16.4
No	5563 (61.2)	58.9-63.5	1,543 (17.8)	16.1-19.6	1,846 (21.0)	19.1-22.8
Child is Safe at School***						
Yes	25,930 (67.7)	66.4-68.7	5,783 (16.5)	15.6-17.4	5,416 (16.0)	15.0-16.9
No	1,430 (57.1)	52.9-61.4	423 (18.4)	15.1-28.2	588 (24.5)	20.8-28.2

*p<.05 **p<.01 ***p<.0001

Looking at the bivariate relationships between school level covariates and the outcome variable, children who repeated at least one grade were 1.5 (95% CI 1.2-1.7) times more likely to be obese than children who never repeated any grades. Also, school engagement was significantly associated with overweight and obesity status among children, where children who were never engaged in school were at an increased likelihood of being overweight (UOR 1.2 95% CI 1.1-1.4) and obese (UOR 1.5 95% CI 1.3-1.7) compared to children who were usually or always engaged in school. Similarly, children who missed over 5 days of school in the past year were 1.2 (95% CI 1.0-1.5) times more likely to be obese than children who didn't miss any days of school in the past year. Children whose parents reported that they were sometimes or never safe at school were more likely to be overweight (UOR 1.3 95% CI 1.0-1.7) and obese (UOR 1.8 95% CI 1.5-2.3) than children who were considered to be usually or always safe at school by their parents (Table 13).

Table 13.
Bivariate Analysis of All School Level Risk Factors by Overweight and Obesity (n=41,361)

	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Characteristics	Unadjusted OR (95% CI)	Unadjusted OR (95% CI)
Number of School Days Missed Past Year**		
0 Days	1.00[b]	1.00[b]
1-5 Days	1.0 (0.8-1.2)	0.9 (0.8-1.1)
More than 5 Days	1.0 (0.8-1.2)	1.2 (1.0-1.5)*
Child Repeated Grade***		
Yes	1.2 (1.0-1.5)	1.5 (1.2-1.7)***
No	1.00[b]	1.00[b]
Child is Engaged in School***		
Yes	1.00[b]	1.00[b]
No	1.2 (1.1-1.4)**	1.5 (1.3-1.7)***
Child is Safe at School***		
Yes	1.00[b]	1.00[b]
No	1.3 (1.0-1.7)*	1.8 (1.5-2.3)***

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

In the final logistic regression model for the school level, after adjusting for all other variables in the model, sex, age, race, mother's education, whether the child is engaged in school, number of school days missed, and if the child is safe at school were all significantly associated with child weight status. There was no change seen in the amount of likelihood between sex, age, race, mother's education and child overweight and obesity from the intrapersonal final logistic regression model (Table 6). Children who were reported to be never engaged in school were 1.3 (95% CI 1.1-1.5) times more likely to be obese than children who were usually or always engaged in school. Children who missed more than 5 days of school were at an increased likelihood of being obese (OR 1.5 95% CI 1.2-1.9) compared to those who didn't miss any days of school. Attending a school that was considered safe was also significantly associated with a child's weight status, where children who attended schools that were considered less safe were 1.4 (95% CI 1.1-1.9) times more likely to be obese than those who attended a school that parents felt were safer. Whether the child ever repeated a grade was not significantly associated with child overweight and obesity, so it was not included in the final regression model (Table 14).

Table 14.
Multinomial Logistic Regression Analysis of All School Level Risk Factors Associated with Child Overweight and Obesity (n=35,779)

	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Characteristics	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Child Sex***		
Male	1.2 (1.1-1.4)**	1.6 (1.3-1.8)***
Female	1.00[b]	1.00[b]
Child Race***		
White	1.00[b]	1.00[b]
Black	1.6 (1.3-1.9)***	1.9 (1.6-2.3)***
Other	1.1 (0.9-1.3)	1.3 (1.0-1.7)*
Child Age***		
10-13 Years	1.6 (1.4-1.8)***	2.0 (1.7-2.3)***
14-17 Years	1.00[b]	1.00[b]
Mother's Highest Education***		
High School or less	1.6 (1.4-1.9)***	2.2 (1.9-2.5)***
More than High School	1.00[b]	1.00[b]
# of School Days Missed Past Year*		

Table 14 (continued)

0 Days	1.00[b]	1.00[b]
1-5 Days	1.1 (0.9-1.3)	1.2 (1.0-1.4)
More than 5 Days	1.2 (0.9-1.4)	1.5 (1.2-1.9)**
Child is Engaged in School**		
Yes	1.00[b]	1.00[b]
No	1.1 (0.9-1.3)	1.3 (1.1-1.5)**
Child is Safe at School*		
Yes	1.00[b]	1.00[b]
No	1.1 (0.9-1.5)	1.4 (1.1-1.9)**

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

Community Level

Within the neighborhoods in which children reside, parents reported a higher proportion of safe (87.6%), supportive (84.1%) neighborhoods with three-four amenities (77.3%) compared to less safe (12.4%), unsupportive (15.9%) neighborhoods with limited or no amenities (22.7%). Multi-collinearity was found between the supportive neighborhood and safe neighborhood risk factors. To solve this the safe and supportive risk factors were combined to create one risk factor, named 'safe and supportive communities'. This variable was a 'yes', 'no' binary variable, where 'yes' meant that the child lived in both a supportive and safe neighborhood. The more neighborhood amenities a child had access to the lower the prevalence of overweight and obesity among children. 9,129 (32.6%) of children who lived in neighborhoods with three-four amenities were overweight and obese compared to 3,314 (35.7%) of children who lived in neighborhoods with two or fewer amenities. Differences in prevalence of overweight and obesity in children were also seen with changes of neighborhood support, where fewer children who lived in supportive neighborhoods were overweight and obese (31.1%) compared to those living in unsupportive neighborhoods (44.6%) (Table15, Table 16).

Table 15.
Descriptive Statistics of All Community Level Risk Factors (n=42,806)

Characteristics	n (%)
Child Lives in a Safe Community	
Yes	38,544 (87.6)
No	3,529 (12.4)
Child Lives in a Supportive Community	
Yes	36,807 (84.1)
No	5,089 (15.9)
Child Lives in a Safe and Supportive Community	
Yes	36,852 (83.5)
No	5,286 (16.5)
# of Amenities in the Community	
0 to 2 Amenities	10,042 (22.7)
3 to 4 Amenities	31,678 (77.3)

*p<.05 **p<.01 ***p<.0001

Table 16.
Descriptive Statistics of All Community Level Risk Factors by Overweight and Obesity (n=41,361)

	Weight Status					
	Healthy Weight		Overweight		Obese	
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
Characteristics	28,573 (66.7)	65.7-67.8	6,495 (16.6)	15.8-17.5	6,293 (16.7)	15.8-17.5
Child Lives in a Safe and Supportive Community***						
Yes	25,155 (68.9)	67.2-69.4	5,472 (15.9)	15.6-17.3	5,102 (15.3)	14.4-16.1
No	3,036 (55.8)	51.6-59.6	911 (20.3)	14.8-20.6	1,077 (25.8)	22.9-30.6
# of Amenities in the Community*						
0 to 2	6,348 (64.3)	62.1-66.4	1,551 (16.5)	14.8-18.2	1,763 (19.2)	17.4-21.0
3 to 4	21,596 (67.4)	66.2-68.7	4,775 (16.7)	15.7-17.7	4,354 (15.9)	14.9-16.9

*p<.05 **p<.01 ***p<.0001

At the bivariate level children who lived in less safe and supportive neighborhoods were 1.6 (95% CI 1.3-1.9) times more likely to be overweight and 1.9 (95% CI 1.6-2.3) times more likely to be obese than children who lived in neighborhoods that were considered safe and supportive. Having access to fewer neighborhood resources and amenities increased the likelihood of being obese (UOR 1.3 95% CI 1.1-1.5) but did not influence the likelihood of children being overweight (UOR 1.0 95% CI 0.9-1.2) (Table 17).

Table 17.
Bivariate Analysis of All Community Level Risk Factors by Overweight and Obesity (n=41,361)

	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Characteristics	Unadjusted OR (95% CI)	Unadjusted OR (95% CI)
Child Lives in a Safe and Supportive Community***		
Yes	1.00[b]	1.00[b]
No	1.6 (1.3-1.9)***	1.9 (1.6-2.3)***
Number of Amenities in the Neighborhood**		
0 to 2 Amenities	1.0 (0.9-1.2)	1.3 (1.1-1.5)**
3 to 4 Amenities	1.00[b]	1.00[b]

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

In the final multiple regression model both community or neighborhood characteristics were found to be significantly associated with childhood overweight and obesity. After adjusting for all variables in the model, sex, age, race, mother's education, if the child lived in a safe and supportive neighborhood and the number of amenities the neighborhood offered were both significantly associated with child weight status. The likelihood associated with sex, age, race, and mother's education were similar to those seen in the previous levels' final logistic regression models (Table 6). Children who lived in neighborhoods that were not considered as safe and supportive were 1.5 (95% CI 1.4-1.8) times more likely to be overweight and 1.7 (95% CI 1.4-2.0) times more likely to be obese than children living in neighborhoods that were considered safe and supportive. The amenities within the neighborhood such as sidewalks and parks had a significant influence on child's weight status. Children who lived in neighborhoods with fewer amenities were

1.2 (95% CI 1.0-1.4) times more likely to be obese compared to those who lived in neighborhoods with more amenities for them to use (Table 18).

Table 18.
Multinomial Logistic Regression Analysis of All Community Level Risk Factors Associated with Child Overweight and Obesity (n=36,665)

Characteristics	Overweight vs. Healthy Weight Adjusted OR (95% CI)	Obese vs. Healthy Weight Adjusted OR (95% CI)
Child Sex***		
Male	1.2 (1.1-1.4)**	1.6 (1.4-1.9)***
Female	1.00[b]	1.00[b]
Child Race***		
White	1.00[b]	1.00[b]
Black	1.4 (1.2-1.7)**	1.8 (1.5-2.2)***
Other	1.1 (0.9-1.3)	1.3 (1.0-1.5)
Child Age***		
10-13 Years	1.5 (1.3-1.7)***	1.9 (1.6-2.2)***
14-17 Years	1.00[b]	1.00[b]
Mother's Highest Education***		
High School or less	1.6 (1.4-1.8)***	2.1 (1.8-2.5)***
More than High School	1.00[b]	1.00[b]
Child Lives in a safe and Supportive Community***		
Yes	1.00[b]	1.00[b]
No	1.5 (1.2-1.8)***	1.7 (1.4-2.0)***
Number of Amenities in the Neighborhood*		
0 to 2 Amenities	1.0 (0.9-1.2)	1.2 (1.0-1.4)*
3 to 4 Amenities	1.00[b]	1.00[b]

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

Combining All Levels

In order to get a complete view of the multiple influences that children are exposed to daily, a stagewise logistic regression analysis was performed. In this analysis SEM level specific covariates were added all together at each stage. All covariates that were significant in the bivariate analysis were included in the stagewise regression. Covariates

were left in the stagewise logistic regression model whether or not they were significant. This was done to see how all of the covariates affected the likelihood of overweight and obesity when combined with each SEM level. In the final model sex, age, race, mother's education, the amount of physical activity a child has weekly, the number of family meals together weekly, the mother's health, if the child participates in activities outside of school, the number of missed school days, and if the child lives in a safe and supportive neighborhood were all significantly associated with child weight status. Males (OR 1.7 95% CI 1.5-2.0) and younger aged children (OR 1.9 95% CI 1.7-2.3) were more likely to be obese than females and older children. Children who were black had a higher likelihood of being overweight (OR 1.4 95% CI 1.1-1.7) and obese (OR 1.8 95% CI 1.4-2.1) compared to children who were white. Children who had mothers with a high school or less education were 1.4 (95% CI 1.2-1.7) times more likely to be overweight and 1.8 (95% CI 1.5-2.1) times more likely to be obese compared to children who had mothers with more than a high school education. Children who participated in 3 or fewer days of physical activity had an increased likelihood of being overweight (OR 1.2 95% CI 1.0-1.4) and obese (OR 1.4 95% CI 1.2-1.6) than those who participated in 4 or more days of physical activity weekly. The child's mother was shown to be a significant influence in child weight status. Mothers who reported their physical and mental health to be poorer were 1.3 (95% CI 1.1-1.5) times more likely to have children who were overweight and 1.6 (95% CI 1.4-1.9) times more likely to have children who were obese compared to mothers who reported better physical and mental health. In this final model an increase in family meals was significantly associated with an increase in weight status, where children who had four or more family meals together per week were more likely to be obese (OR 1.3 CI 1.1-1.6) than children who ate fewer meals together as a family per week. A child's participation in activities outside of school was shown to decrease their likelihood of being overweight or obese, where children who did not participate in any activities were 1.5 (95% CI 1.2-1.8) times more likely to be obese than their peers who did participate in outside activities. For school influences the number of days missed from school was the only significant covariate left in the final stagewise logistic regression model. Children who missed 5 or more days of school were at an increased likelihood of being obese (OR 1.4 CI 1.1-1.8) compared to children who didn't miss any days of school in the past year. Safety and support were the two

community covariates that had a significant relationship with child overweight and obesity in this study. Living in neighborhoods that were considered less safe and supportive increased the likelihood of overweight (OR 1.4 95% CI 1.1-1.7) and obesity (OR 1.3 95% CI 1.0-1.6) compared to children who lived in safer neighborhoods. Odds ratios between each risk factor and overweight and obesity did not change greatly in the final stagewise logistic regression model compared to the final individual level models (Table 19).

Table 19.

Stagewise Multinomial Logistic Regression Adjusted Odds Ratios (95% CI) of SEM Level Risk Factors and Child Overweight and Obesity (n=35,023)

	Model 1: Intrapersonal Level (n=36,866)		Model 2: Model 1 + Interpersonal Level (n=36,490)		Model 3: Model 2 + School Level (n=35,247)		Model 4: Model 3 + Community Level (n=34,751)	
Characteristics	Overweight vs. Healthy Weight	Obese vs. Healthy Weight	Overweight vs. Healthy Weight	Obese vs. Healthy Weight	Overweight vs. Healthy Weight	Obese vs. Healthy Weight	Overweight vs. Healthy Weight	Obese vs. Healthy Weight
Sex***								
Male	1.3 (1.1-1.4)**	1.7 (1.5-2.0)***	1.3 (1.1-1.5)**	1.8 (1.5-2.0)***	1.3 (1.1-1.5)**	1.7 (1.5-2.0)***	1.3 (1.1-1.5)**	1.7 (1.5-2.0)***
Female	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Race***								
White	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Black	1.5 (1.3-1.8)***	1.9 (1.6-2.3)***	1.4 (1.2-1.7)**	1.7 (1.4-2.0)***	1.4 (1.2-1.8)**	1.7 (1.4-2.1)***	1.4 (1.1-1.7)**	1.8 (1.4-2.1)***
Other	1.1 (0.9-1.3)	1.3 (1.0-1.6)*	1.1 (0.9-1.3)	1.2 (1.0-1.6)	1.0 (0.9-1.3)	1.2 (1.0-1.6)	1.0 (0.8-1.3)	1.2 (1.0-1.6)
Child Age***								
10-13 Years	1.6 (1.4-1.8)***	2.0 (1.7-2.3)***	1.6 (1.4-1.8)***	2.0 (1.7-2.3)***	1.6 (1.4-1.8)***	2.0 (1.7-2.4)***	1.6 (1.4-1.8)***	2.0 (1.7-2.3)***
14-17 Years	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Mother's Highest Education***								
HS or less	1.6 (1.4-1.9)***	2.2 (1.9-2.5)***	1.4 (1.2-1.7)***	1.7 (1.5-2.0)***	1.4 (1.2-1.7)***	1.8 (1.5-2.1)***	1.4 (1.2-1.7)***	1.8 (1.5-2.1)***
More than HS	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Days of Physical Activity**								
0 - 3 Days Weekly	1.2 (1.0-1.4)*	1.4 (1.2-1.7)***	1.2 (1.0-1.4)*	1.4 (1.2-1.6)***	1.2 (1.0-1.4)*	1.4 (1.2-1.6)**	1.2 (1.0-1.4)*	1.4 (1.2-1.6)**
4 - 7 Days Weekly	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Time Spent Watching TV								
< 1 Hours Daily	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
1+ Hours Daily	1.0 (0.8-1.3)	0.8 (0.6-1.0)	1.1 (0.8-1.3)	0.9 (0.7-1.2)	1.1 (0.8-1.3)	0.9 (0.7-1.1)	1.1 (0.8-1.4)	0.9 (0.7-1.2)
Family Structure**								
2-Parent Household			1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Other			1.2 (1.0-1.4)	1.5 (1.2-1.7)***	1.1 (1.0-1.3)	1.4 (1.2-1.6)***	1.1 (1.0-1.3)	1.4 (1.1-1.6)**
Mother's Health***								
Very Good or Excellent			1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
Good or Poor			1.3 (1.2-1.5)***	1.8 (1.5-2.0)***	1.3 (1.1-1.6)**	1.7 (1.4-1.9)***	1.3 (1.1-1.5)**	1.6 (1.4-1.9)***
Days Have Family Meals Together**								
0 – 3 Days Weekly			0.9 (0.8-1.1)	0.7 (0.6-0.9)***	0.9 (0.8-1.1)	0.7 (0.6-0.9)**	1.00[b]	1.00[b]
4 - 7 Days Weekly			1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.2 (1.0-1.4)	1.4 (1.2-1.6)**
Child Participates in Outside Activities**								
Yes			1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]	1.00[b]
No			1.3 (1.0-1.5)*	1.5 (1.3-1.9)***	1.2 (1.0-1.5)	1.5 (1.3-1.9)***	1.2 (1.0-1.5)	1.5 (1.2-1.8)**
# of School Days Missed Past Year*								
0 Days					1.00[b]	1.00[b]	1.00[b]	1.00[b]
1-5 Days					1.1 (0.9-1.3)	1.2 (1.0-1.4)	1.1 (0.9-1.3)	1.2 (1.0-1.4)

Table 19 (continued)

More than 5 Days		1.1 (0.9-1.4)	1.4 (1.1-1.8)**	1.1 (0.9-1.4)	1.4 (1.1-1.8)**
Child Repeated Grade					
Yes		1.0 (0.9-1.3)	1.0 (0.8-1.2)	1.0 (0.8-1.3)	1.0 (0.8-1.3)
No		1.00[b]	1.00[b]	1.00[b]	1.00[b]
Child is Engaged in School					
Yes		1.00[b]	1.00[b]	1.00[b]	1.00[b]
No		1.0 (0.9-1.2)	1.2 (1.0-1.4)	1.0 (0.8-1.2)	1.1 (0.9-1.3)
Child is Safe at School					
Yes		1.00[b]	1.00[b]	1.00[b]	1.00[b]
No		1.0 (0.8-1.4)	1.2 (0.9-1.5)	1.0 (0.8-1.3)	1.2 (0.9-1.5)
Child Lives in a Safe and Supportive Community**					
Yes				1.00[b]	1.00[b]
No				1.4 (1.1-1.7)**	1.3 (1.0-1.6)*
# of Amenities in the Community					
0 - 2 Amenities				1.0 (0.9-1.2)	1.2 (1.0-1.4)*
3 - 4 Amenities				1.00[b]	1.00[b]

1.00[b]: reference category
*p<.05 **p<.01 ***p<.0001

Chapter 5

DISCUSSION

Childhood overweight and obesity can be influenced by the culmination of multiple exposures that children are faced with daily. To further understand these exposures, this study used the 2011-2012 NSCH to assess how SEM level risk factors influence childhood overweight and obesity independently and collectively. At each level there were multiple covariates that were significantly associated with a child's likelihood of being overweight or obese. When the levels were combined we were able to see a clearer picture of the many exposures children face daily in the manner in which they are faced, which is collectively. These multiple exposures are carried with children throughout the day and should be understood both independently and all together.

Intrapersonal Level

The most personal characteristics and behaviors of a child are found within the intrapersonal level (Institute of Medicine, 2003). Research has shown that childhood obesity is disproportionately experienced by children from lower income and minority families (Miguel-Etayo et al., 2013). In this study disparities between race and socioeconomic status and child overweight and obesity were very clear. This was seen with an increased likelihood of black children being overweight and obese compared to that of white children. Maternal education was assessed in this study as a proxy for income because research has shown that parents with a lower level of educational attainment have been seen to have an increased likelihood of having overweight and obese children (Veldhuis et al., 2013). In this study children who had mothers with less education were twice as likely to be obese than children who had mothers with higher level of education. Child physical activity was shown to be protective against overweight and obesity likelihood. Children who were active less had an increased likelihood of being overweight or obese. Physical activity has long been associated with decreased BMI (Anzman-Frasca et al., 2013). Increasing one's amount of physical activity has been recommended as a key strategy in curbing the alarming rate of childhood overweight and obesity (Sigmund et al.,

2014). Increasing the amount of physical activity may also help to decrease the overweight and obesity disparity seen by race and income level. Engaging in physical activity is now widely accepted as an effective preventive measure for overweight and obesity status across all ages, sex, and ethnic and social subgroups (Sigmund et al., 2014). Although sedentary behavior such as extensive time spent watching TV has been associated with an increased likelihood of overweight and obesity among children (Byrne et al., 2011), it was not significantly associated with child overweight and obesity in this study. This may be because screen time has become more of the norm for children and adolescents. This may blur the line of its influence on overweight and obesity likelihood.

Many of these intrapersonal risk factors that are significantly associated with overweight and obesity in children are not changeable. When disparities in overweight and obesity status are seen in unchangeable risk factors such as age, race, gender, and income level, it is important to look more closely at the system or construct that originally facilitated the disparity. The idea of obesity puts more responsibility on the individual and the environment and ignores the system in which the individual lives (Hendrie et al., 2013). One purpose of this study was to understand not only the individual level risk factors associated with child weight status but also to understand all components of a child's environment in order to identify not only behavior changes but also needed system changes.

Interpersonal Level

The interpersonal level explores the exposures common to a child's family and home life. Parents have been shown to be very influential to child health outcomes and behaviors (Institute of Medicine, 2013). Parents are responsible for the food children eat, the rules they follow, and the access they have to resources that promote and hinder positive health behavior. The structure of the family is a very basic component to a child's home environment. We found that children in households that have two parents have a much lower likelihood of being overweight and obese than children with other types of parental support. Families with single parents have been found to have an increased likelihood of having children who are overweight or obese (Byrne et al., 2011). Within the

family parental health, mainly maternal, is a proven indicator associated with childhood overweight and obesity (Reifsnider et al., 2010). Maternal health is predominantly a product of the mother's own health behaviors. These behaviors and beliefs are often the same that they expose their children to (Veldhuis et al., 2013). In our study mother's health was significantly associated with the likelihood of overweight and obesity in their children. Children who had mothers who reported having poorer physical and mental health were significantly more likely to be overweight or obese. Closely related to parental health behavior is the number of meals of the family eats at home per week. Home-cooked meals often have increased levels of nutrition and fewer calories and additives, making them a healthier option for children to eat (Larson et al., 2013). We found that the number meals a family had together weekly had the opposite effect on the likelihood of childhood overweight and obesity than was anticipated. The more meals the family had together the greater the likelihood of a child being overweight or obese. This could be due to many factors. The biggest factor concerning eating family dinners outside of the home is time. Often families with children who participate in many sports and activities outside school are not home during dinner, making the number of meals that these families eat outside of the home higher than those who did not participate in activities. Participation in such activities outside of school has been shown to decrease the likelihood of overweight and obesity in children (Flynn, 2013). This was demonstrated in our study. Children who participated in outside activities were a significantly lower likelihood of being overweight or obese than children who did not participate in activities outside of school. Finally, the presence of a TV in a child's bedroom was not found to be significantly associated with child overweight and obesity in this study. This risk factor is very similar to the intrapersonal risk factor regarding time spent watching TV daily. Research has shown that a TV in a child's bedroom is associated with increased time watching TV and an increased likelihood of overweight and obesity (Byrne et al.). In these data over 60% of the sample had a TV in their bedroom. This may coincide with the hypothesis that it has become more common to have increased access to technology, weakening the relationship between sedentary behavior and child weight status.

School Level

Children spend more time in school than any other environment outside of their homes. At least 95% of American youth aged 5 to 17 are enrolled in school (Story et al., 2009). School is one setting that children are exposed to repeatedly and continuously throughout the majority of their childhood and adolescence (Brug et al., 2010). Schools can play a critical role in supporting and promoting health behaviors by establishing a safe and supportive environment (CDC, 2014). We looked at several school level factors that demonstrated the influence of a supportive environment on child overweight and obesity likelihood. One major component of a supportive environment relates to whether the child is considered to be safe at school. We found that children who were not attending a school considered to be safe had an increased likelihood of being overweight or obese. A significant influence that affects how safe a child feels at school is whether there is a lot of bullying and peer victimization (Lumeng et al., 2010). Bullying at school has long been associated with decreased feelings of being safe at school, feelings of distress, and an increased likelihood of overweight and obesity among children (Lumeng et al., 2010). Interest and involvement in school and grades is also a predictor for overweight and obesity status among children (Puhl et al., 2012). In this study students who showed minimal to no engagement and interest in school were at an increased likelihood of being overweight or obese. This may also be supported by research that has found that students who have poor school experiences such as being victimized or isolated have less interest in their education and grades (Puhl et al., 2012). School absenteeism reflects general life stressors associated with both physical and mental health issues (Van Hook et al., 2011). We found a slightly significant association between missing more than 5 days of school in the past year and obesity likelihood. A predominant motivator for children to miss school days links back with the topic of school support and enjoyment. Children who are not in a safe, supportive school environment have been found to be at an increased likelihood of absenteeism and overweight and obesity (Van Hook et al., 2011).

Community Level

Ecological models suggest that overweight and obesity is not just determined by individual characteristics but also by the environment in which the individual is situated (CDC, 2013). The neighborhood is a social environment includes safety from crime and support from neighbors (Pearson et al., 2011). In this study children who lived in neighborhoods that were considered less safe and were unsupportive were significantly more likely to be overweight or obese. The safety of the neighborhood has a major influence on how often a child can go outside and participate in more activity (Pearson et al., 2011). By living in a neighborhood that isn't considered safe, children are not able to spend as much time outdoors being physically active (Pearson et al., 2011). Decreased opportunity for physically active play has been found to be associated with an increased likelihood of overweight and obesity among children (Carson et al., 2014). In this study, a supportive neighborhood was one where neighbors helped each other, looked out after each other's children, could count on each other, and trusted other adults in the neighborhood with their children. The respondents who lived in supportive neighborhoods had the confidence in their neighbors that their children were being protected and looked after when outdoors. Parents who feel their children are being looked after and protected while outside are more likely to allow their children to play outside, increasing the opportunity for them to engage in physically active play (Pearson et al., 2011). We found this to be true in our study, where an increased likelihood in childhood overweight and obesity was seen among children who lived in unsupportive neighborhoods. Access to amenities such as sidewalks, parks, and recreation centers within the built neighborhood environment has also been shown to influence the amount of physical activity a child participates in (Carson et al., 2014). In this study children who had access to more amenities were at a decreased likelihood of being obese than children who did not have access to as many amenities within their neighborhood.

Combining All Levels

When each stage was added to the model the same risk factors that were not significant in the individual level regressions were also not significant in this analysis. However, within the school level if a child was engaged in school and if the child was safe at school were no longer significant in this final model. Also, in the community level, the number of neighborhood amenities a child had access to was not significant in this model. One purpose of this research was to assess the risk factors of each level individually and then when all levels were combined. We found the inclusion of additional risk factors within this analysis led to less influential variables being dropped from the final model. This demonstrates the importance of not only understanding the exposures of each individual level but also how these influences change in likelihood when they are all combined.

When all of the levels were combined into one final model, the risk factors that had the greatest influence on childhood overweight and obesity were the sociodemographic risk factors, sex, race, age, and mother's education. An additional risk factor in this analysis that had a strong influence over child overweight and obesity was mother's health. As discussed earlier, there has been strong evidence that shows how healthy mothers tend to have children with healthier weight statuses (Semmler et al., 2009). Mothers who are healthy are often more likely to be physically active and play with their children. Also, mothers who are at a healthy weight have an increased likelihood of having children at a healthy weight (Dunton et al., 2012).

Combining all of the individual SEM levels together allowed us to see which of a child's daily exposures were most influential above all others. Assessing individual level risk factors gave us a better understanding of the exposures that influence a child's health behaviors and outcomes within each specific environment. Combining all of the levels together let us see how the odds ratios evolved when assessed within a more real perspective of what children experience daily. Observing some of the risk factors that were significant in the individual levels become insignificant when combined with all other SEM

levels helps to affirm that the multiple exposures at each level are interrelated and should be considered collectively when addressing childhood obesity prevention.

Strengths of the Study

This study used the 2011-2012 NSCH, which contains a large selection of sociodemographic, behavior, and health status risk factors. With this large selection this study was able to assess common exposures from different levels of a child's environment and determine how they are associated with child weight status. The NSCH is a population-based survey, so all findings can be applied to the US population of children aged 10-17. This makes the findings useful for recommending both policy and program creation and change. The large sample size of these data allowed for multiple risk factors and multiple levels of analysis without compromising statistical relevance. Finally, there is little research that has been able to capture the depth of an SEM analysis by each level individually and with all levels combined. These findings, which are predominantly consistent with current research, offer additional depth to what is currently available regarding socio-ecological modeling of childhood overweight and obesity research.

Limitations of the Study

Much like all epidemiological studies, there were limitations to this research. A primary limitation is that the survey items are answered by parent-report regarding their children's characteristics and behaviors, including the child's height and weight. Parent-reported heights and weights have been shown to be less accurate than measurements in a clinical setting (Shields, Conner-Gerber, Janssen, & Tremblay, 2011). However, at the population level, uses of self-reported height and weight measurements are often the only option available and have been proven to be useful when analyzing associations (Shields et al., 2011). Height and weight were only asked of children aged 10-17. This limited our ability to consider this to be representative of the entire U.S. population of children, instead it is only representative of children and adolescents aged 10-17. Another limitation is the unavailability of needed level specific risk factors. Such risk factors include nutrition and food intake preferences specific to the child, nutrition and food practices in the home, and nutrition and physical education information at the school level. Also, policy related risk

factors that are common and measurable to the general U.S. child population would be useful to add one more SEM level to this analysis. The availability of these variables would have created more complete individual level analyses and a more detailed picture of daily child exposures when combined. This study was a cross-sectional analysis of child characteristics and behaviors as reported in 2011-2012. This study is only able to calculate the likelihood of a child being overweight or obese. The cause of overweight and obesity among children cannot be determined in this study.

Future Uses and Public Health Impact

Addressing the magnitude of the childhood obesity epidemic requires the development of multi-level and cross-sectional interventions (Leroux et al., 2012). Ecological modeling, much like what was done in this study, is needed for interventions in order to target determinants at all levels and to reduce barriers that influence poor health behaviors (Simon et al., 2014). From the current literature available, it can be concluded that individual causes of overweight and obesity still receive more attention than collective, socio-ecological causes (Wieringa et al., 2008). Moving away from an individual model where energy balance is the central premise to explain obesity to a more dynamic model that considers biological, behavioral, and environmental influences will work to not only address the behavior change, also the environment that may have created the behavior initially (Wieringa et al., 2008). This is the first population based, analytical, Socio-Ecological based study conducted in the U.S. The results of this study can be used to tailor more informed interventions that contain significant risk factors from each SEM level. Looking into future childhood obesity efforts, this study demonstrates that individuals need to be viewed beyond their isolated, individual selves and be considered within the larger social units in which they live (Townsend & Foster, 2011). There needs to be a paradigm shift with obesity programs and initiatives with more attention focused on the environments in which these children live and ways to make changes within the environment that ultimately leads to the development of more healthful behaviors in the beginning of their lives (Townsend & Foster, 2011). Although it is more difficult and has an increased cost, the development of policies, interventions, and programs that reach multiple levels of a child's environment and have buy-in from those who influence the

child's life are going to be the best option for effective and sustainable obesity control and prevention. Children have multiple influences, many of which that they have limited control over, that affect their health behaviors and decisions. These environmental influences need to be considered if their behavior change is desired.

Conclusion

This study found multiple risk factors associated with child overweight and obesity in each of the four SEM levels. The findings from each individual level provide insight as to the factors that significantly influence childhood overweight and obesity in each major environment that a child experiences. When all of the individual levels were combined three risk factors that were significant at their respective levels were no longer significant. This demonstrates the importance of researching and tackling the childhood obesity epidemic from multiple facets instead of one focal point. It is necessary to understand and consider the risk factors from all levels of exposure and how they influence the likelihood of childhood overweight and obesity. Research has shown that focusing on single, individual levels of a child's socio-ecological influences has ended with limited long-term success in tackling childhood overweight and obesity. This is because there are significant risk factors that influence childhood overweight and obesity at each of those four levels. Until all risk factors are controlled, successful long-term obesity prevention may not be possible. These findings have the potential to benefit any SEM research addressing childhood weight status and help guide and support the development of more inclusive obesity prevention interventions, programs, and policies.

REFERENCES

Aljunaibi, A., Adbulle, A., & Nagelkerke, N. (2013). Parental weight perceptions: a cause for concern in the prevention and management of childhood obesity in the United Arab Emirates. *PLoS ONE,* 8(3), e59923. doi: 10.1371/journal.pone.0059923

Anzman-Frasca, S., Newman, MB., Angstrom, HM., Sharma, S., Nelse, ME., Dolan, P., & Economos, CD. (2013). Parent perspectives on nutrition and physical activity during out-of-school time. *Journal of Nutrition Education and Behavior.* doi: 10.1016/j.jned.2013.09.011

Bauer, KW., Berge, JM., & Neumark-Sztainer, D. (2011). The importance of families to adolescents' physical activity and dietary intake. *Adolesc Med,* 601-613.

Birch, LL., & Davidson, KK. (2001). Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Childhood and Adolescent Obesity,* 48(4) 893-905.

Birch, LL., & Ventura, AK. (2009). Preventing childhood obesity: What works? *International Journal of Obesity,* 33, S74-S81. doi: 10.1038/ijo.2009.22

Blumberg, ST., Bramlett, MD., Kogan, MD., Scieve, LA., Jones, JR., & Lu, MC. (2013). Changes in prevalence of parent reported autism spectrum disorder in school-aged U.S. children: 2007 to 2011-2012. *National Health Statistics Report,* 65(1) 1-11.

Bowring, AL., Peeters, A., Freak-Poli, R., Lim, M., Gouillou, M., & Hellard, M. (2012). Measuring the accuracy of self-reported height and weight in a community-based sample of young people. *BMC Medical Research Methodology.* 12(1), 175-182. doi: 10.1186/1471-2288-12-175.

Bramlett, MD., & Blumberg, SJ. (2007). Family structure and children's physical and mental health. *Health Affairs,* 26(2), 549-558. doi: 10.1377/hlthaff.26.2.549

Branscum, P., & Sharma, M. (2012). After-school based obesity prevention interventions: a comprehensive review of the literature. *Int J Environ Res Public Health,* 9, 1438-1457. doi: 10.3390/ijerph9041438

Brennan, LK., Brownson, RC., & Orleans, CT. (2014). Childhood overweight and obesity policy research and practice evidence for policy and environmental strategies. *Am J Prev Med.* 46(1), e1-e16. doi: 10.1016/j.amepre.2013.08.022

Briefel, RR., Crepinsek, MK., Cabili, C., Wilson, A., & Gleason, PM. (2009). School food environments and practices affect dietary behaviors of US public school children. *J Am Diet Assoc,* 109(1), S91-S107. doi: 10.1016/j.jada.2008.10.059

Brown, KA., Ogden, J., Vogele, C., & Gibson, EL. (2008). The role of parental control practices in explaining children's diet and BMI. *Appetite,* 50, 252-259. doi: 10.1016/j.appet.2007.10.010

Bruening, M., Eisenberg, M., MacLehose, R., Nanney, MS., Story, M., & Neumark-Sztainer, D. (2012). The relationship between adolescent's and their friends' eating behaviors-breakfast, fruit, vegetable, whole grain, and dairy intake. *J Acad Nutr Diet,* 112(10), 1608-1613. doi: 10.1016/j.jand.2012.07.008

Brug, L., Te Velde, SJ., Chinapaw, MJ., Bere, E., De Bourdeaudhuij, I., Moore, H…. & Singh, AS. (2010). Evidence-based development of school-based and family-involved prevention of overweight across Europe: The ENERGY-project's design and conceptual framework. *BMC Public Health,* 10, 276. Doi: 10.1186/1471-2458-10-276

Byrne, LK., Cook, KE., Skouteris, H., & Do, M.(2011). Parental status and childhood obesity in Australia. *International journal of Pediatric Obesity,* 6, 415-428. doi: 10.3109/17477166.2011.598938

Campbell, KJ., Crawford, DA., Salmon, J., Carver, A., Garnett, SP., & Baur, LA. (2007). Associations between the home food environment and the obesity-promoting eating behaviors in adolescence. *Obesity,* 15(3), 719-730. doi: 10.1038/oby.2007.553

Canadas, L., Veiga, OL. & Martinez-Gomez, D. (2014). Important considerations when studying the impact of physical activity on health in youth. *BMC Pediatrics,* 14, 75. doi: 10.1186/1471-2431-14-75

Carson, VS., Rosu, A., & Janssen, I. (2014). A cross-sectional study of the environment, physical activity, and screen time among young children and their parents. *BMC Public Health,* 14(1), 61. doi: 10.1186/1471-2458-14-61

Centers for Disease Control and Prevention, Healthy Weight. (2014). Healthy weight – it's not a diet, it's a lifestyle. *About BMI for Children and Teens*. Retrieved from website: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html#What%20is%20BMI%20percentile. Accessed 2/10/2014.

Centers for Disease Control and Prevention, Adolescent and School Health. (2014). *Childhood obesity facts*. Retrieved from website: http://www.cdc.gov/healthyyouth/obesity/facts.htm

Centers for Disease Control and Prevention, Adolescent and School Health. (2014). *Nutrition and the health of young people*. Retrieved from website: http://www.cdc.gov/healthyyouth/nutrition/facts.htm

Centers for Disease Control and Prevention, Adolescent and School Health. (2014). *Physical activity and the health of young people*. Retrieved from website: http://www.cdc.gov/healthyyouth/physicalactivity/facts.htm

Centers for Disease Control, "Make a difference at your school" (2013). *Chronic Disease.* Paper 31. http://digitalcommons.hsc.unt.edu/disease/31. Accessed, 2/10/2014.

Centers for Disease Control and Prevention, Office of Injury Control & Prevention. (2013). *The social-ecological model: A framework for prevention*. Retrieved from website: http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html

Centers for Disease Control and Prevention, National Center for Health Statistics. (2012). *Prevalence of obesity among children and adolescents: United States, trends 1963-1965 through 2009-2010.* Retrieved from website: http://www.cdc.gov/nchs/data/hestat/obesity_child_09_10/obesity_child_09_10.pdf .

Chen AY., & Escarce, JJ. (2013). Family structure and childhood obesity: An analysis through 8th grade. *Maternal and Child Health Journal.* doi: 10.1007/s10995-013-1422-7

Chen, AY., & Escarce, JJ. (2010). Family structure and childhood obesity, early childhood longitudinal study – kindergarten cohort. *Preventing Chronic Disease,* 7(3). http://www.cdc.gov/pcd/issues/2010/may/09_0156.htm. Accessed 2/1/2014.

Child and Adolescent Health Measurement Initiative (2012). "2011/12 National Survey of Children's Health (2012), Sampling and Survey Administration." Data Resource Center, supported by Cooperative Agreement 1-U59-MC06980-01 from the U.S. Department of Health and Human Services, Health Resources and Services

Administration (HRSA), Maternal and Child Health Bureau (MCHB). Available at www.childhealthdata.org . Revised 01/10/13.

Chriqui, JF., Pickel, M., & Story, M. (2014). Influence of school competitive food and beverage policies on obesity, consumption, and availability. A systematic review. *JAMA Pediatr.* 168(3), 279-286. doi: 10.1001/jamapediatrics.2013.4457

Collins, CE., Watson, J., & Burros, T. (2010). Measuring dietary intake in children and adolescents in the context of overweight and obesity. *International Journal of Obesity,* 34(1), 1103-1115. doi: 10.1038/ijo.2009.241

Corder, K., Crespo, NC., Van Sluijs, EMF., Lopez, NVS., & Elder, JP. (2012). Parent awareness of young children's physical activity. *Prevs. Med.,* 55(3), 201-205. doi: 10.1016/j.ypmed.2012.06.21

Daniels, DY. (2008). Examining attendance, academic performance, and behavior in obese adolescents. *JOSN,* 24(6), 378-387. doi: 10.1177/1059840508324246

Danubio, ME., Miranda, G., Vinicguerra, MG., Vecchi, E., & Ruffo, F. (2007). Comparison of self-reported and measured height and weight: Implications for obesity research among young adults. *Economics and Human Biology*, 6(1), 181-190. doi: 10.1016/j.ehb.2007.04.002

Datar, A., & Nicosia, N. (2012). Junk food in schools and childhood obesity. *J Policy and Manage,* 31(2), 312-337. doi: 10.1002/pam.21602

Davis, DS., Goldmon, MVS., & Coker-Appiah, DS. (2011). Using a community-based participatory research approach to develop a faith-based obesity intervention for African Americans. *Health Promotion Practice,* 12(1), 811-822. doi: 10.1177/1524839910376162

Davison, KK., Jurkowski, JM., Kaigang, L., Kranz, S., & Lawson, HA. (2013). A childhood obesity intervention developed by families for families: Results from a pilot study. *International Journal of Behavioral Nutrition and Physical Activity,* 10, 3. doi: 10.1186/1479-5868-10-3

Davison, KK., Jurkowski, JM., & Lawson, HA. (2012). Reframing family-centered obesity prevention using the family ecological model. *Public Health Nutrition.* doi: 10.1017/s1368980012004533

Dev, DA., McBride, BA., Fiese, BH., Jones, BL., & Cho, H. (2013). Risk factors for overweight and obesity in preschool children: an ecological approach. *Childhood Obesity,* 9(5), 399-408. doi: 10.1089/chi.2012.0150

Dietary Guidelines Advisory Committee. *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010, to the Secretary of Agriculture and the Secretary of Health and Human Services.* Washington, DC: U.S. Department of Agriculture; 2010.

Domingo, IS., & Scheimann, AO. (2012). Overview of the epidemiology and management of childhood obesity. *Minerva Pediatr,* 64(6), 607-613.

Drake, KM., Beach, ML., Longrace, MR., MacKenzie, T., Titus, LJ., Rundle, AG., & Dalton, MA. (2014). Influence of sports, physical education, and active commuting to school on adolescent weight status. *Pediatrics,* 130(2), e296-e304. doi: 10.1542/peds.2011-2898

Drieling, RL., Rosas, LG., Ma, J., & Stafford, RS. (2014). Community resource utilization, psychosocial health, and sociodemographic factors associated with diet and physical activity among low-income obese Latino immigrants. *Journal of Academy of Nutrition and Dietetics,* 114, 257-265. doi: 10.1016/j.and.2013.07.025

Dubois, L., Farmer, A., Girard, M., & Peterson, K. (2008). Social factors and TV use during meals and snacks is associated with higher BMI among pre-school children. *Public Health Nutrition,* 11(12), 1267-1279. doi: 10.1017/S13168980008002887

Dunton, GF., Liao, Y., Almanza, E., Jerrett, M., Chou, C., & Pentz, MA. (2012). Joint physical activity and sedentary behavior in parent-child pairs. *Med Sci Sports Exerc,* 44(8), 1473-1480. doi: 10.1249/MSS.ob013e31825148e9

Ebbeling, CB., Pawlak, DB., & Ludwig, DS. (2002). Childhood obesity: Public health crisis, common sense cure. *The Lancet,* 10, 473-482. doi: 10.1016/S0140-6736(02)09678-2

Edwardson, CL., & Gorely, T. (2010). Activity-related parenting practices and children's objectively measured physical activity. *Pediatric Exercise Science,* 22, 105-113.

Elkins, WL., Cohen, DA., Koralewicz, LM., & Taylor, SN. (2004). After school activities, overweight, and obesity among inner city youth. *Journal of Adolescence,* 27(1), 181-189. doi: 10.1016/j.adolescence.2003.10.010

Ewald, H., Kirby, J., Rees, K., & Robertson, W. (2013). Parent-only interventions in the treatment of childhood obesity: A systematic review of randomized controlled trials. *Journal of Public Health. Doi: 10.1093/pubmed/fdct108*

Fiese, BH., & Jones, BL. (2012). Food and family: A socio-ecological perspective for child development. *Advances in Child Development Behavior,* 42, 307-337. doi: 10.1016/B978-0-12-394388-0.00009-5

Finkelstein, EA., Graham, WCK., & Malhotra, R. (2014). Lifetime direct medical costs of childhood obesity. *Pediatrics,* 135(5). doi: 10.1542/peds.2014-0063

Fitzgerald, A., Fitzgerald, N., & Aherne, C. (2012). Do peers matter? A review of peer and/or friends' influence on physical activity among American adolescents. *Journal of Adolescents,* 35(1), 941-958. doi: 10.1016/j.adolescence.2012.01.002

Flynn, J. (2013). The changing face of pediatric hypertension in the era of the childhood obesity epidemic. *Pediatr Nephrol,* 28(1), 1059-1066. doi: 10.1007/s0047-012-2344-0

Food Research and Action Center (FRAC). (2012). *School meal nutrition standards.* Retrieved from website: http://frac.org/federal-foodnutrition-programs/national-school-lunch-program/school-meal-nutrition-standards/

Formisano, A., Hunsberger, M., Bammann, K., Vanaelst, B., Molnar, D., Moreno, L…. Siani, A. (2013). Family structure and childhood obesity: Results of the IDEFICS project. *Public Health Nutrition*, 1-9. doi: 10.1017/s1368980013002474

Foster, GD., Sundal, D., Lent, MR., McDermott, C., Jelalian, E., & Vojta, D. (2013). 18-month outcomes of a community-based treatment for childhood obesity. *Pediatric Obesity,* 10.1111/j.2047-6310.2013.00187.x

Fox, MK., Dodd, AH., Wilson, A., & Gleason, PM. (2009). Association between school food environment and practices and body mass index of US public school children. *Am J Diet Assoc,* 109(1), S108-S117. doi: 10.1016/j.jada.2008.10.65

Fuemmeler, BF., Anderson, CB., & Masse, LC. (2011). Parent-child relationship of directly measured physical activity. *International Journal of Behavioral Nutrition and Physical Activity,* 8(1),17. doi: 10.1186/1479-5868-8-17

Gable, S., Chang, Y., & Krull, JL. (2007). TV watching and frequency of family meals are predictive of overweight onset and persistence in a national sample of school-aged children. *J Am Diet Assoc,* 107(1), 53-61. doi: 10.1016/j.jada.2006.10.010

Giles-Corti, B., Kelty, SF., Zubrick, SR., & Villanueva, KP. (2009). Encouraging walking for transport and physical activity in children and adolescents. *Sports Med,* 39(12), 995-1009. doi: 10.2165/11319620-000000000-00000

Gilliland, JA., Rangel, CY., Healy, MA., Tucker, P., Loebach, JE., Hess, PM…. & Wilk, P. (2012). Linking childhood obesity to the built environment: A multi-level analysis of home and school neighborhood factors associated with body mass index. *Canadian Journal of Public Health,* 103(3), S15-S21.

Glavin, K., Roelants, M., Strand, BH., Juliusson, PB., Lie, KM., Helseth, S., & Hovengen, R. (2014). Important periods of weight development in childhood: A population-based longitudinal study. *BMC Public Health,* 14(1), 160-167. doi: 10.1186/1471-2458-14-160

Golan, M. (2006). Parents as agents of change in childhood obesity – from research to practice. *International Journal of Pediatric Obesity,* 1(2), 66-76. doi: 10.1080/17477160600644272

Goldfield, GS., Kenny, GP., Hadjiyannakis, S., Phillips, P., Alberga, AS., Sounders, TJ…. & Sigal, RJ. (2011). Video game playing is independently associated with blood pressure and lipids in overweight and obese adolescents. *PLoS ONE,* 6(11), e26643. doi: 10.1371/journal.pone.0026643

Gonzales-Suarez, C., Worley, A., Grimmers-Somers, K., & Dones, VS. (2009). School-based interventions on childhood obesity. *Am J Prev Med,* 37(5), 418-427. doi: 10.1016/j.amepre.2009.07.012

Gose, M., Plachta-Danielzik, S., Williw, B., Johannsen, M., Landsberg, B., &Muller, MJ. (2013). Longitudinal influences of neighbourhood built and social environment on children's weight status. *Int.J. Environ. Res. Public Health,* 10(1), 5083-5096. doi: 10.3390/jjerph10105083

Grow, HM., Hencz, P., Verbovski, MJ., Gregerson, L., Liu, LL., Dossett, L…. & Saelens, BE. (2014). Partnering for success and sustainability in community-based child obesity

intervention. *Family Community Health,* 37(1), 45-59. doi: 10.1097/fch.0000000000000010

Gruber, KJ., & Haldeman, LA. (2009). Using the family to combat childhood and adult obesity. *Preventing Chronic Disease,* 6(3).

Gubbels, JS., Kremers, SPJ., Stafleu, A., De Vries, S., Goldbohm, RA., Dagnelie, PC…. & Thijs, C. (2011). Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA birth cohort study. *International Journal of Behavioral Nutrition and Physical Activity,* 8(1), 18. doi: 10.1186/1479-5658-8-18

Gubbels, JS., Van Assema, P., & Kremers, SPJ. (2013). Physical activity, sedentary behavior, and dietary patterns among children. *Curr Nutr Rep,* 2(1), 105-112. doi: 10.1007/s13668-013-0042-6

http://www.cdc.gov/pcd/issues/2009/jul/08_0191.htm. Accessed 2/10/2014.

Hamid, F., Islam, R., & Chandraray, P. (2013). Childhood obesity – an emerging problem: a review article. *Bangladesh J Child Health,* 37(2), 122-126. doi: 10.3329/bjch.v37i2.17269

Harrison, F., & Jones, AP. (2011). A framework for understanding school based physical environmental influences on childhood obesity. *Health Place,* 18(3), 639-648. doi: 10.1016/j.healthplace.2011.12.009

Hartstein, J., Cullen, KW., Virus, A. & El Ghormli, L., Volpe, SL., Staten, MA….& Mobley, CC. (2013). Impact of the HEALTHY study on vending machine offerings in middle schools. *J Child Nutr Manag,* 35(2), 16353.

Hawkins, SS., Cole, TJ., & Law, C. (2009). An ecological systems approach to examine risk factors for early childhood overweight: Findings from the UK millennium cohort. *J Epidemiol Community Health,* 63(2), 147-155. doi: 10.1136/jech.2008.077917

He, M., Tucker, P., Irwin, JD., Gilliland, J., Larsen, K., & Hess, P. (2012). Obesogenic neighbourhoods: the impact of neighbourhood restaurants and convenience stores on adolescents' food consumption behaviours. *Public Health Nutrition,* 15(12), 2331-2339. doi: 10.1017/S1368980012000584

Hendrie, G., Sohonpal, G., Lange, K., & Golley, R. (2013). Change in the family food environment is associated with positive dietary change in children. *International*

Journal of Behavioral Nutrition and Physical Activity, 10(1), 4. doi: 10.1186/1479-5868-10-4

Hernan, MA., Hernandez-Diaz, S., Werler, MM., & Mitchel, AA. (2002) Causal knowledge as a prerequisite for confounding evaluation: An application to birth defects epidemiology. *American Journal of Epidemiology*, 155(2), 176-184.

Hood, MY., Sundarajan-Ramamurti, A., Singer, M., Cupples, LA., & Ellison, RC. (2000). Parental eating attitudes and the development of obesity in children. The Framingham children's study. *International Journal of Obesity,* 24(10), 1319-1325. doi:10.1038/sj.ijo.0801396

Hunsberger, M. (2014). Early feeding practices and family structure: associations with overweight in children. *Proceedings of the Nutrition Society,* 73, 132-136. doi: 10.1017/S0029665113003741

Huybrechts, I., De Bourdeaudhuij, I., & De Henauw, S. (2010). Environmental factors: Opportunities and barriers for physical activity, and healthy eating among children and adolescents. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsshuttz,* 53(7), 716-724. doi: 10.1007/s00103-010-1085-0

Institute of Medicine. *Who will keep the public healthy? Educating public health professionals for the 21st century.* Washington, DC: The National Academies Press, 2003.

Jago, R., Davison, KK., Thompson, JL., Brockman, R., & Fox, KR. (2011). Parental sedentary restriction, maternal parenting style, and TV viewing among 10- to 11-year-olds. *Pediatrics,* 128, e572-e578. doi: 10.1542/peds.2010-3664

Jago, R., Fox, KR., Page, AS., Brockman, R., & Thompson, JL. (2010). Parent and child physical activity and sedentary time: do active parents foster active children? *BMC Public Health,* 10(1), 194. doi: 10.1186/1471-10-194

Jong, ED., Visscher, TLS., HiraSing, RA., Heymans, MW., Seidell, JC., & Renders, CM. (2013). Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. *International Journal of Obesity,* 37(1), 47053. doi: 10.1038/ijo.2011.244

Keane, E., Layte, R., Harrington, J., Kearney, PM., & Perry, IJ. (2012). Measured parental overweight and obesity and familial socio-economic status correlates with

childhood overweight and obesity at age 9. *PLoS ONE,* 7(8), e43503. doi: 10.1371/jurnal.pone.0043503

Kim, KH., Linnan, L., Campbell, MK., Brooks, C., Koenig, HG., & Wiesen, C. (2006). The WORD (wholeness, oneness, righteousness, deliverance): A faith-based weight-loss program utilizing a community-based participatory research approach. *Health and Behavior,* 35, 634-650. doi: 10.1177/1090198106291985

Kirby, J., Levin, KA., & Inchley, J. (2012). Associations between the school environment and adolescent girls' physical activity. *Health Education Research,* 27(1), 101-114. doi: 10.1093/her/cyr090

Klakk, H., Chinapaw, M., Heidmann, M., Anderson, LB., & Wedderkopp, N. (2013). Effect of four additional physical education lessons on body composition in children aged 8-13 years – a prospective study during two school years. *BMC Pediatrics,* 13(1), 170. doi: 10.1186/1471-2431-13-170

Koletzko, B., Von Kries, R., Monasterolo, RC., Subias, JE., Scaglioni, S., Giovannini, M…. & Grote, VS. (2009). Infant feeding and later obesity risk. *Adv Exp Med Biol,* 646, 15-29. doi: 10.1007/978-1-4020-9173-5_2

Krahmstoever, K., Cutting, TM., & Birch, LL. (2003). Parent's activity-related parenting practices predict girls' physical activity. *Med Sci Sports Exerc,* 35(9), 1589-1595. doi: 10.1249/MSS.0000084524.19408.0C

Kothandan, SK. (2014). School based interventions versus family based interventions in the treatment of childhood obesity – a systematic review. *Archives of Public Health,* 72, 3. doi: 10.1186/2049-3258-72-3

Langille, JD., & Rodgers, WM. (2010). Exploring the influence of a social ecological model on school-based physical activity. *Health Education and Behavior,* 37(6), 879-894. doi: 10.1177/1090198110367877

Larson, N., MacLehose, R., Fulkerson, JA., Berge, JM., Story, M., & Neumark-Sztainer, D. (2013). Eating breakfast and dinner together as a family: Associations with sociodemographic characteristics and implications for diet quality and weight status. *Journal of the Academy of Nutrition and Dietetics,* 113(1), 1601-1609. doi: 10.1016/j.jand.2013.08.011

Lavelle, HVS., Mackay, DF., & Pell, JP. (2012). Systematic review and meta-analysis of school-based interventions to reduce body mass index. *Journal of Public Health,* 34(3), 360-369. doi: 10.1093/pubmed/fdr116

Lazarou, C., Kalvana, T., & Matalas, AL.(2008). The influence of parents' dietary beliefs and behaviours on children's dietary beliefs and behaviours. The CYKIDS study. *Appetite,* 51, 690-696. doi:10.1016/j.appet.2008.06.006

Leech, RM., McNaughton, SA., & Timperio, A. (2014). Clustering of children's obesity-related behaviours: associations with sociodemographic indicators. *European Journal of Clinical Nutrition,* 106. doi: 10.1038/ecjn.2013.295

Leroux, JS., Moore, S., & Dube, L. (2013). Beyond the "I" in the obesity epidemic: A review of social relational and network interventions on obesity. *Journal of Obesity.* doi: 10.1155/2013/348249

Li, Y., Raychowdhury, S., Tedders, SH., Lyn, R., Lopez-De Fede, A., & Zhang, J. (2012). Association between increased BMI and severe school absenteeism among US children and adolescents: Findings from a national survey, 2005-2008. *International Journal of Obesity,* 36(1), 517-523. doi: 10.1038/ijo.2012.15

Lindsay, AC., Sussner, KM., Kim, J., & Gortmaker, S. (2006). The role of parents in preventing childhood obesity. *The Future of Children,* 16(1), 169-186. doi: 10.1353/foc.2006.0006

Lytle, LA. (2009). Examining the etiology of childhood obesity: The IDEA study. *Am J Community Psychol,* 44(3-4), 338. doi: 10.1007/s10464-009-9269-1

Lumeng, JC., Forrest, P., Appugliese, DP., Kaciroti, N., Corwyn, RF., & Bradley, RH. (2010). Overweight and obesityas a predictor of being bullied in third through sixth grade. *Pediatrics,* 125(6), e1300-e1307. doi: 10.1542/peds.2009.0774

Maitland, C., Stratton, G., Foster, S., Braham, R., & Rosenberg, M. (2013). A place to play? The influence of the home physical environment on children's physical activity and sedentary behavior. *International Journal of Behavioral Nutrition and Physical Activity,* 10(1), 99. doi: 10.1186/1479-5868-10-99

Marviscin, D., & Danford, CA. (2013). Parenting efficacy related to childhood obesity: Comparison of parent and child perceptions. *Journal of Pediatric Nursing,* 28(1), 422-429. doi: 10.1016/j.pedn.2012.11.004

Maynard, MJ., Baker, G., Rawlins, E., Anderson, A., & Harding, S. (2009). Developing obesity prevention interventions among minority ethnic children in schools and places of worship: The DEAL (diet and active living) study. *BMC Public Health,* 9, 480. doi: 10.1186/1471-2458-9-480

McVey, GL., Walker, KS., Beyers, J., Harrison, HL., Simkins, SW., & Russel-Mayhew, R. (2013). Integrating weight bias awareness and mental health promotion into obesity prevention delivery: A public health pilot study. *Preventing Chronic Disease,* 10. doi: 10.5888/pcd10.120185

Miguel-Etayo, PD., Bueno, G., Garagorri, JM., & Moreno, LA. (2013). Interventions for treating obesity in children. *World Rev Nutr Diet,* 108, 98-196. doi: 10.1159/00351493

Minor, MO. (2012). Faith-based advocacy to end childhood obesity: Using evidence-based information. *Childhood Obesity,* 8(1), 16-18. doi: 10.1089/chi.2011.0123

Mitchell, JA., Pate, RR., Beets, MW., & Nader, PR. (2013). Time spent in sedentary behavior and changes in childhood BMI: A longitudinal study from ages 9-15. *International Journal of Obesity,* 37, 54-60. doi: 10.1038/ijo.2012.41

Mitchell, J., Rodriguez, D., Schmitz, K., & Audrain-McGovern, J. (2013). Greater screen time is associated with adolescent obesity: A longitudinal study of the BMI proportion from ages 14 to 18. *Obesity*, *21*(3), 525-575. doi:10.1002/oby.20157

Moreno, LA., Bel-Serrat, S., Santaliestra-Pasias, AM., & Rodriguez, G. (2013). Obesity prevention in children. *World Rev Nutr Diet,* 106, 119-126. doi: 10.1159/00342560

Morton, KL., Wilson, AH., Perlmutter, LS. & Beauchamp, MP. (2012). Family leadership styles and adolescent dietary and physical activity behaviors: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity,* 9(1),48. doi: 10.1186/1479-5868-9-48

National Center for Health Statistics, US Department of Health and Human Services. (2012). *The national survey of children's health (NSCH), 2011–2012: the public use data file and documentation*. Hyattsville, Md, USA. Retrieved from http://www.cdc.gov/nchs/slaits/nsch.htm. Accessed 4/25/2014.

Nemiary, D., Shim, R., Mattox, G., & Holden, K. (2012). The relationship between obesity and depression among adolescents. *Psychiatr Ann,* 42(8), 305-308. doi: 10.3928/00485713-20120806-09

Neumark-Sztainer, D., Hannan, PJ., Story, M., Croll, J., & Perry, C. (2003). Family meal patterns: Associations with sociodemographic characteristics and improved dietary intake among adolescents. *J Am Diet Assoc.,* 103(1), 317-322. doi: 10.1053/jada.2003.50048

Oen, G., & Stormark, KM. (2013). Participatory action research in the implanting process of evidence-based intervention to prevent childhood obesity: Project design of the "Healthy Future" study. *Journal of Obesity.* doi: 10.1155/2013/437206

Ogden, L., Carroll, MD., Jit, BK., & Flegal, KM. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA,* 311(8), 806-814. doi: 10.1001/jama.2014.732

Orban, KO., Edberg, AK., Thorngren-Jerneck, K., Onnerfalt, J., & Erlandsson, LK. (2013). Changes in parents' time use and its relationship to child obesity. *Physical and Occupational Therapy in Pediatrics,* 1-18. doi: 10.3109/01942638.2013.792311

Osei-Assibey, G., Dick, S., Macdiarmid, J., Semple, S., Reilly, JJ., Ellaway, A…. & McNeill. (2012). The influence of the food environment on overweight and obesity in young children: A systematic review. *BMJ Open,* 2, e001538. doi: 10.1136/bmjopen-2012-001538

Pan, L., Sherry, B., Park, S., & Blanck, HM. (2013). The association of obesity and school absenteeism attributed illness or injury among adolescents in the United States, 2009. *Journal of Adolescent Health,* 52(1), 64-69. doi: 10.1016/j.adolhealth.2012.04.003

Parizkova, J., Roville-Sausse, F., & Molnar, D. (2013). Interdisciplinary aspects of childhood obesity and physical fitness. *Journal of Obesity,* 2013. doi: 10.1155/2013/828463

Pearson, N., Salmon, J., Crawford, D., Campbell, K., & Timperio, A. (2011). Are parental concerns for child TV viewing associated with child TV viewing in the home sedentary environment? *International Journal of Behavioral Nutrition and Physical Activity,* 8(1), 102. doi: 10.1186/1479-5868-8-102

Porter, CM. (2013). Community action to prevent childhood obesity: Lessons from three US case studies. *Childhood Obesity,* 9(2), 164-174. doi: 10.1089/chi.2012.0018

Potestio, ML., Patel, AB., Powell, CD., McNeill, DA., Jacobsen, RD., & McLaren, L. (2009). Is there an association between spatial access to parks/green space and childhood overweight/obesity in Calgary, Canada? *International Journal of Behavioral Nutrition and Physical Activity,* 6(1). doi: 10.1186/1479-5868-6-77

Power, TG., Bindler, RC., Goetz, S.,& Daratha, KB. (2010). Obesity prevention in early adolescence: Student, parent, and teacher views. *Journal of School Health,* 80(1), 13-19. doi: 10.1111/j.1746-1561.2009.00461.x

Puhl, RM., & Luedicke, J. (2012). Weight-based victimization among adolescents in the school setting: Emotional reactions and coping behaviors. *J Youth Adolescence,* 41(1), 27-40. doi: 10.1007/s10964-011-9713-z

Puhl, RM., & Peterson, JL. (2012). Strategies to address weight-based victimization: Youths' preferred support interventions from classmates, teachers, and parents. *J Youth Adolescence.* doi: 10.1007/s10964-012-9849-5

Pulgaron, ER. (2013). Childhood obesity: A review of increased risk for physical and psychological comorbidities. *Clinical Therapeutics,* 35(1), A18-A32. doi: 10.1016/j.clinthera.2012.12.014

Raychaudhuri, M., & Sanyal, D. (2012). Childhood obesity: Determinants, evaluation, and prevention. *Indian J Endocrinol Metab,* 16(2), S192-S194. doi: 10.4103/2230-8210.104037

Reed, SF.,Viola, JJ., & Lynch, K. (2014). School and community-based childhood obesity: Implications for policy and practice. *Journal of Prevention & Intervention in the Community,* 42(2), 87-94. doi: 10.1080/10852352.2014.881172

Reedy J., & Krebs-Smith, SM. (2010). Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *Journal of the American Dietetic Association,* 110(1), 1477–1484.

Reifsnider, E., Hargraves, M., Williams, KJ., & Cooks, J. (2010). Shaking and rattling: Developing a child obesity prevention program using a faith-based community approach. *Fam Community Health,* 33(2), 144-151. doi: 10.1097/FCH.0b013e3181d59487

Reilly, JJ., & Kelly, J. (2011). Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. *International Journal of Obesity,* 35(1), 891-898. doi: 10.1038/ijo.2010.222

Ridgers, ND., Stratton, G., Fairclough, SJ., & Twisk, JW. (2007). Long-term effects of a playground markings and physical structures on children's recess physical activity levels. *Prev med,* 44, 393-397. doi: 10.1016/j.ypmed.2007.01.009

Robinson, S. (2006). Victimization of obese adolescents. *The Journal of School Nursing,* 22(4), 201-206. doi: 10.1177/10598405050220040301

Rosenkranz, RR., & Dzewaltowski, DA. (2009). Model of the home food environment pertaining to childhood obesity. *Nutrition Reviews,* 66(3), 123-140. doi: 10.1111/j.1743-4887.2008.00017.x

Rundle, A., Quinn, J., Lovasi, G., Bader, M., Yousefzadeh, P., Weiss, C., & Neckerman, K. (2013). Associations between body mass index and park proximity, size, cleanliness, and recreational facilities. *Am J Health Promot.* 27(4), 262-269. doi: 10.4278/ajhp.110809-quan-304

Sabin, MA., & Shield, JPH. (2008). Childhood obesity. *Obesity and Metabolism,* 36(1), 85-06. doi: 10.1159/000115356

Salvey, SJ., Haye, K., Bowker, JC., & Hermans, RCJ. (2012). Influence of peers and friends on children's and adolescents' eating and activity behaviors. *Physiol Behav,* 106(3), 369-378. doi: 10.1016/j.physbeh.2012.03.022

Salvey, SJ., Roemmich, JN., Bowker, JC., Romero, ND., Stadler, PJ., & Epstein, LH. (2008). Effect of peers and friends on youth physical activity and motivation to be physically active. *Journal of Pediatric Psychology,* 34(2), 217-225. doi: 10.1093/jpepsy.jsn071

Sarrafzadegan, N., Rabeie, K., Nouri, F., Mohammadifard, N., Moatter, F., Roohafza, H…. & Pourmoghaddas, M. (2013). Parental perceptions of overweight and obesityof their children. *ARYA Atheroscler,* 9(1), 61-69.

Scaglioni, S., Salvoni, M., & Galimberti, C. (2008). Influence of parental attitudes in the development of children eating behavior. *British Journal of Nutrition,* 99(1), S22-S25. doi:10.1017/S000711-4508892471

Schaub, J., & Marian, M. (2011). Reading, writing, and obesity: America's failing grade in school nutrition and physical education. *Nutrition in Clinical Practice,* 26(5), 553-564. doi: 10.1177/0884533611416820

Schmidt, ME., Haines, J., O'Brien, A., McDonald, J., Price, S., Sherry, B., & Taveras, EM. (2012). Systematic review of effective strategies for reducing screen time among young children. *Obesity,* 20(7), 1338-1354. doi: 10.1038/0by.2011.348

Semmler, C., Ashcroft, J., Van Jaarsveld, CHM., Carnell, S., & Wardle, J. (2009). Development of overweight in children in relation to parental weight and socioeconomic status. *Obesity,* 17(4) 814-820. doi: 10.1038/oby.2008.621

Sharma, M. (2011). Dietary education in school-based childhood obesity prevention programs. *Adv Nutr,* 2, 207S-216S. doi: 10.3945/an.111.000315

Shields, M., Connor-Gerber, S., Janssen, I., & Tremblay, MS. (2011) Obesity estimates for children based on parent-reported versus direct measures. *Statistics Canada; Health Reports*, 22(3). doi: 10.1016/S1499-2671(11)52024-6

Sigmund, E., Sigmundova, D., Hamrik, Z., & Geckova, AM. (2014). Does participation in physical education reduce sedentary behavior in school and throughout the day among normal-weight and overweight-to-obese Czech children aged 9-11 years? *Int. J. Environ. Res. Public Health,* 11(1), 1076-1093. doi: 10.3390/ijerph110101076

Simon C., Kellou, N., Dugas, J., Platat C., Copin, N., Schweitzer, B., Hausser, F… & Blanc S. (2014). A socio-ecological approach to promoting physical activity and limiting sedentary behavior in adolescence showed weight benefits maintained 2.5 years after intervention cessation. *International Journal of Obesity.* 38(7), 936-944. Doi: 10.1038/ijo.2014.23

Skinner, AC., & Skelton, JA. (2014). Prevalence and trends in obesity and severe obesity among children in the United States, 1999-2012. *JAMA Pediatrics.* doi: 10.1001/jamapediatrics.2014.21

Smith, BJ., Grunsett, A., Hardy, LL., King, L., Wolfenden, L., & Milat, A. (2010). Parental influences on child physical activity and screen time viewing: A population based study. *BMC Public Health,* 10, 593. doi: 10.1186/1471-2458-10-593

Sobol-Goldberg, S., Rabinowitz, J., & Gross, R. (2013). School-based obesity prevention programs: A meta-analysis of randomized control trials. *Obesity,* 21(12), 2422-2428. doi: 10.1002/oby.20515

Spruij-Metz, D. (2011). Etiology, treatment and prevention of obesity in childhood and adolescence: A decade in review. *J Res Adolesc,* 21(1), 129-152. doi: 10.1111/j.1532-7795.2010.00719.x.

Story, M., Nanney, MS., & Schwartz, MB. (2009). Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *The Millbank Quarterly,* 87(1), 71-100. doi: 10.1111/j.1468-0009.2009.00548.x

Swinburn, B., Malakellis, M., Moodie, M., Waters, E., Gibbs, L., Millar, L…. & De Silva-Sanigorski, A. (2013). Large reductions in child overweight and obesity in intervention and comparison communities 3 years after a community project. *Pediatric Obesity.* doi: 10.111/j.2047-6310.2013.00201.x

Tandon, PS., Zhou, C., Sallis, JF., Cain, KL., Frank, LD., & Saelens, BE. (2012). Home environment relationships with children's physical activity, sedentary time, and screen time by socioeconomic status. *International Journal of Behavioral Nutrition and Physical Activity,* 9(1), 88. doi: 10.1186/1479-5868-9-88

Tappe, KA., Glanz, K., Sallis, JF., Zhou, C., & Saelens, BE. (2013). Children's physical activity and parents; perception of the neighborhood environment: Neighborhood impact on kids study. *International Journal of Behavioral Nutrition and Physical Activity,* 10, 39-48. doi: 10.1186/1479-5868-10-39

Taras, H., & Potts-Datema, W. (2005). Obesity and student performance at school. *Journal of School Health.* 75(8), 291-295. doi: 10.1111/j.1746-1561.2005.tb07346.x

Tarro, L., Lluarado, E., Albaladejo, R., Morina, D., Arija, VS., Sola, R., & Giralt, M. (2014). A primary-school-based study to reduce the prevalence of childhood obesity – the EAI (educacio en alimentacio) study: a randomized controlled trial. *Trials,* 14(1), 58. doi: 10.1186/1745-6215-15-58

Telford, RD., Cunningham, RB., Fitzgerald, R., Olive, LS., Prosser, L., Jiang, X., & Telford, RM. (2012). Physical education, obesity, and academic achievement: A 2-year longitudinal investigation of Australian elementary school children. *American Journal of Public Health,* 102(2), 368-374. doi: 10.2105/ajph.2011.300220

Thompson, JL., Davis, SM., Gittelsohn, J., Becenti, A., Metcalf, L…. & Ring, K. (2001). Patterns of physical activity among American Indian children: An assessment of barriers and support. *Journal of Community Health,* 26, 423-445. doi: 10.1023/A:1012507323784

Tovar, A., Chui, K., Hyatt, RR., Kuder, J., Kraak, VI., Choumenkovitch, SF…. & Economos, CD. (2012). Healthy- lifestyle behaviors associated with overweight and obesity in US rural children. *BMC Pediatrics,* 12(1),102. doi: 10.1186/1471-2431-12-102

Townsend, N. & Foster, C. (2011). Developing and applying a socio-ecological model to the promotion of health eating in school. *Public Health Nutrition.* doi: 10.1017/S1368980011002655

Tremblay, MS., LeBlanc, AG., Kho, ME., Saunders, TJ., Larouche, R., Colley, RC… & Gorber, SC. (2011). Systematic review of sedentary behavior and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity,* 8:98, http://www.ijbnpa.org/content/8/1/98. Accessed 2/2/2014.

United States Department of Agriculture, Food and Nutrition Service. (2014). *National School Lunch Program (NSLP).* Retrieved from website: http://www.fns.usda.gov/nslp/national-school-lunch-program .

United States Department of Agriculture, Food and Nutrition Service. (2014). *Local School Wellness Policy.* Retrieved from website: http://www.fns.usda.gov/tn/local-school-wellness-policy.

U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010,* 7th Edition. Washington, DC, US Government Printing Office; 2010.

University of Victoria, Centre for Addictions Research of BC. *Theoretical Foundation; What is Health Promotion*. (2013). Retrieved February 18, 2014, from http://www.carbc.ca/KnowledgeinPractice/HealthyCommunities/BackgroundTheory.aspx .

Van Hook, J., & Altman, CE. (2011). Competitive food sales in schools and childhood obesity: A longitudinal study. *Sociology of Education,* 85(1), 23-39. doi: 10.1177/0038040711417011

Veldhuis, L., Vogel, I., Van Rossem, L., Renders, SM., HiraSing RA., Mackenbach, JP., & Raat, H. (2013). Influence of maternal and child lifestyle-related characteristics on the

socioeconomic inequality in overweight and obesity among 5-year-old children; The "be active, eat right" study. *International Journal of Environmental Research and Public Health,* 10, 2336-2347. doi: 10.3990/ijerph10062336

Vine, M., Hargreaves, MB., Briefel, RR., & Orfield, C. (2013). Expanding the role of primary care in the prevention and treatment of childhood obesity: A review of clinic-community-based recommendations and interventions. *Journal of Obesity.* doi: 10.1155/2013/172035

Wang, Y., Wu, Y., Wilson, RF., Bleich, S., Cheskin, L, Weston C, Showell N…. & Segal J. (2013). Childhood obesity prevention programs: Comparative effectiveness review and meta-analysis. Comparative effectiveness review No. 115. (Prepared by the Johns Hopkins University Evidence-based Practice Center under Contract No. 290-2007-10061-I.) AHRQ Publication No. 13-EHC081-EF. Rockville, MD: Agency for Healthcare Research and Quality. www.effectivehealthcare.ahrq.gov/reports/final.cfm.

Wang, Y. (2011). Disparities in pediatric obesity in United States. *Advances in Nutrition,* 2, 23-31. doi: 10.3945/an.110.000083

Wieringa, NF., Van der Windt, HJ., Zuiker, RRM., Dijkhuizen, L., Verkerk, MA., Vonk, RJ., & Swart, JAA. (2008). Positioning functional foods in an ecological approach to the prevention of overweight and obesity. *Obesity Reviews,* 9, 464-473. doi: 10.1111/j.1467-789X.2008.00470.x

Williams, AJ., Henley, WE., Williams, CA., Hurst, AJ., Logan, S., & Wyatt, KM. (2013). Systematic review and meta-analysis of the association between childhood overweight and obesity and primary school diet and physical activity policies. *International Journal of Behavioral Nutrition and Physical Activity,* 10(1), 101. doi: 10.1186/1479-5868-10-101

Williams, J., Scarborough, P., Matthews, A., Cowburn, G., Foster, C., Roberts, N., & Rayner, M. (2014). A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obesity Reviews.* doi: 10.1111/obr.12142

Wilson, SM., & Sato, AF. (2014). Stress and pediatric obesity: What we know and where to go. *Stress Health,* 30(2), 91-102. doi: 10.1002/smi.2501

Wyse, R., Campbell, E., Nathan, N., & Wolfenden, L. (2011). Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study. *BMC Public Health,* 11(1), 938. doi: 10.1186/1471-11-938

Yin, HS., Sanders, LM., Rothman, RL., Shustak, R., Eden, SK., Shintani, A…. & Perrin, EM. (2014). Parent health literacy and "obesogenic" feeding and physical activity-related infant care behaviors. *Journal of Pediatrics,* 164, 577-583. doi: 10.1016/j.jpeds.2013.11.014

Zarrett, N., & Bell, BA. (2014). The effects of out-of-school time on changes in youth risk of obesity across the adolescent years. *Journal of Adolescence.* 37(1), 85-96. doi: 10.1016/j.adolescence.2013.11.001

Ziebarth, D., Healy-Haney, N., Gnadt, B., Cronin, L., Jones, B., Jensen, E., & Viscuso, M. (2012). A community-based family intervention program to improve obesity in Hispanic Families. *WMJ,* 111(6), 261-266.

VITA

KATIE CALLAHAN-MYRICK

Education:	DrPH: (Doctor of Public Health), East Tennessee State University, USA, 2014
	MPH: (Master of Public Health), San Diego State University, USA, 2011
	BS: (Bachelor of Science), University of Maine, USA, 2009
	BA: (Bachelor of Arts), University of Maine, USA, 2003
Professional Experience:	Surveillance Coordinator and Chronic Disease Epidemiologist, South Carolina Department of Health and Environmental Control, 2013-Present
	Adult Worksite Wellness Coordinator, Healthy Androscoggin, 2013
	Principal Investigator of a Smoking in Vehicles Study, University of Maine, 2008-2011
	USDA Summer Food Service Program Coordinator, Somerset Heart Health, 2009
	Americorps Vista Volunteer, Somerset Heart Health, 2008-2009
Publications:	Callahan, K. (2014). 2013 Children's Health Assessment Survey Methodology Report. (in final review)
	Callahan, K. (2014). 2012 Children's Health Assessment Survey Methodology Report. (in final review)
	Callahan K. & Heidari, K. (2013). 2012 South Carolina Children's Health Reports: Childhood Overweight and Obesity. Available at: http://www.scdhec.gov/Health/docs/CHAS/2012ChildrenHealthReport.pdf

Cao, Y., Callahan, K., Veeranki, SP., Chen, Y., Liu, X. & Zheng, S. (2014). Vitamin D status and demographic and lifestyle determinants among adults in the United States (NHANES 2001-2006). *Advance Journal of Food Science and Technology*, 6(6), 743-750. Doi:

Chen, Y., Strasser, S., Callahan, K., Blackley, B., Cao, Y. Wang, L., & Zheng, S. (2014). The association of calcium intake and other risk factors with cardiovascular disease among obese adults in USA. *Advance Journal of Food Science and Technology.* 6(3), 333. Doi:

Wang, K., Liu, X., Zheng, S., Zheng, M., Pan, Y. & Callahan, K., (2012). A novel locus for body mass index on 5p15.2: A meta-analysis of two genome-wide association studies. *Gene.* 500(1), 80-84.

Presentations:

Callahan, K. & Heidari, K. The association between parental diabetes status and other indicators with child weight status. South Carolina Annual Diabetes Symposium, 2014

Callahan, K. & Heidari, K. The prevalence of childhood overweight and obesity in South Carolina. Council of State and Territorial Epidemiologists Annual Meeting, 2014

Callahan, K. & Zheng, S. Prevalence of Lime Disease in Maine, 2009-2012. ETSU Appalachian Student Forum, 2012

Callahan, K. Factors associated with smoking in vehicles containing children. ETSU Appalachian Student Forum, 2011

Callahan, K. Factors associated with smoking in vehicles containing children. APHA, 2010