Longitudinal validity of the FNPA screening tool to predict changes in weight status in children

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Longitudinal validity of the FNPA screening tool to predict changes in weight status in children

by

Karissa Peyer

A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY

Major: Kinesiology

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Ames, Iowa
2016

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# Table of Contents

LIST OF FIGURES ........................................................................................................... v  
LIST OF TABLES ............................................................................................................. vi  
LIST OF SYMBOLS or ABBREVIATIONS ...................................................................... vii  
ACKNOWLEDGEMENTS ................................................................................................. viii  
ABSTRACT ....................................................................................................................... ix  

CHAPTER 1. INTRODUCTION ......................................................................................... 1  
1.1 References ................................................................................................................ 6  

CHAPTER 2. REVIEW OF THE LITERATURE ................................................................ 9  
2.1 Prevalence and Consequences of Childhood Overweight and Obesity ............ 9  
2.2 Clinical Health Risks Associated with Overweight in Youth ......................... 12  
2.3 Factors Influencing Pediatric Obesity ................................................................. 16  
  2.3.1 Physical Activity .............................................................................................. 16  
  2.3.2 Screen Time .................................................................................................... 18  
  2.3.3 Sleep ................................................................................................................ 22  
  2.3.4 Nutrition .......................................................................................................... 24  
2.4 Family Components of Obesity ......................................................................... 26  
  2.4.1 Parental Influence .......................................................................................... 27  
  2.4.2 Sociodemographic Indicators ....................................................................... 31  
2.5 The FNPA: Uses and Future Directions .............................................................. 33  
2.6 Tables and Figures ............................................................................................... 37  
2.7 References ............................................................................................................. 40  

CHAPTER 3. AN UPDATE TO THE FAMILY NUTRITION AND PHYSICAL ACTIVITY (FNPA) SCREENING TOOL ........................................ 55  
3.1 Abstract .................................................................................................................. 55  
3.2 Introduction ............................................................................................................. 56  
3.3 Methods .................................................................................................................. 59  
  3.3.1 Revision of FNPA Items .................................................................................. 59  
  3.3.2 Phase I – Cognitive Testing .......................................................................... 60  
  3.3.3 Phase II – Quantitative Evaluation ............................................................... 61  
3.4 Data Analyses ....................................................................................................... 62  
3.5 Results .................................................................................................................... 63  
  3.5.1 Phase I ............................................................................................................. 63  
  3.5.2 Phase II ........................................................................................................... 64  
3.6 Discussion .............................................................................................................. 66  
3.7 Tables ..................................................................................................................... 70  
3.8 References ............................................................................................................. 74
APENDIX D. GRADING THE STRENGTH OF THE EVIDENCE 
FOR A CONCLUSION STATEMENT .........................................................143
APENDIX E. EVIDENCE ANALYSIS SUMMARY ........................................145
APENDIX F. FOUR VERSIONS OF THE FNPA ..............................................146
APENDIX G. DEMOGRAPHIC SURVEY FOR STUDY 2 AND STUDY 3 ........158
APENDIX H. MODIFIED USDA US FOOD SECURITY SURVEY MODULE.160
LIST OF FIGURES

Figure 2.1 Ecological model of predictors of child health...............................38
Figure 2.2 Birch and Fisher’s theoretical model of the family environment and
daughter’s weight status...........................................................................38
Figure 2.3 Flowchart of evidence analysis for the development of the FNPA........39
Figure 4.1 Weight category distribution by grade and gender.............................100
Figure 5.1 Participant flow through follow-up .................................................128
Figure 5.2 Weight category distribution by grade and gender.............................128
Figure 5.3 Overall growth trajectory for all participants with 1st grade BMI and
follow-up......................................................................................................129
Figure 5.4a Growth rate groups for all participants with BMI data....................129
Figure 5.4b Growth rate groups for all participants with BMI and survey data......129
LIST OF TABLES

Table 2.1 Prevalence of obesity among children and adolescents ages 2-19 years: United States.................................................................37
Table 2.2 Aspects of parenting styles ..................................................39
Table 2.3 Obesity prevalence by racial/ethnic group.................................37
Table 3.1 Items, responses and Recommended Practices for the FNPA .............70
Table 3.2 Survey allocations for Phase II ..............................................73
Table 4.1 Descriptive statistics by age group .........................................93
Table 4.2a FNPA scores by gender, family income, school SES level and race in 1st grade students..............................................................194
Table 4.2b FNPA scores by gender, family income, school SES level and race in 10th grade students ............................................................95
Table 4.3 Correlations among FNPA constructs for 1st grade student ..........96
Table 4.4 Correlations among FNPA constructs for 10th grade student .........97
Table 4.5a Results of regression analyses examining factors contributing to BMI% in first grade...............................................................98
Table 4.5b Results of regression analyses examining factors contributing to BMI50 in first grade .........................................................98
Table 4.6a Results of regression analyses examining factors contributing to BMI% in 10th grade ............................................................99
Table 4.6b Results of regression analyses examining factors contributing to BMI50 in 10th grade ............................................................99
Table 5.1 Demographics of the sample with baseline FNPA and BMI% at 1st and 10th grade ................................................................125
Table 5.2 Maximum likelihood estimates for group assignment base on risk factors ...........................................................................126
Table 5.3 Hierarchical linear models for growth trajectory for BMI% and BMI50.127
LIST OF SYMBOLS OR ABBREVIATIONS

NHANES: National Health and Nutrition Examination Survey
BMI: Body Mass Index
HDL: High-Density Lipoprotein
FNPA: Family Nutrition and Physical Activity Screening Tool
CDC: Centers for Disease Control and Prevention
T2DM: Type 2 Diabetes Mellitus
LDL: Low-Density Lipoprotein
EMR: Electronic Medical Record
OSAS: Obstructive Sleep Apnea Syndrome
OR: Odds Ratio
YRBSS: Youth Risk Behavior Surveillance System
WIC: Special Supplemental Nutrition Program for Women, Infants and Children
mmHg: Millimeters of Mercury
Kcal/min: Kilocalories per minute
SSB: Sugar-sweetened Beverages
EAH: Eating in the Absence of Hunger
CVD: Cardiovascular Disease
PSDQ: Parenting Styles and Dimensions Questionnaire
ANOVA: Analysis of Variance
SBRS: Survey and Behavioral Research Services
Sub: Subjective without Recommended Practices
SubRP: Subjective with Recommended Practices
Obj: Objective without Recommended Practices
ObjRP: Objective with Recommended Practices
BMI%: BMI Percentile
FRLP%: Percent of students eligible for the Free and Reduced-Price Lunch Program
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ABSTRACT

The increasing prevalence of overweight and obesity and the accompanying co-morbidities among children and adolescents in recent decades is cause for public health concern. Many factors influence weight status and obesity risk, but little research has examined the influence of the home environment on weight status across different age groups, particularly in longitudinal designs. The Family Nutrition and Physical Activity (FNPA) screening tool is a validated measure of the home environment, but further testing of the tool is needed. The purposes of this dissertation were to 1) compare various versions of the FNPA to evaluate user perceptions and test reliability, 2) to determine the efficacy of the FNPA and influence of socio-demographic variables on weight status in children and adolescents and, 3) to examine the influences of home environment and economic factors on long-term growth trajectories among youth.

The first study provided support for the continued use of the subjective (Almost Never/Sometimes/Often/Almost Always) response scale based on superior test-retest reliability and inter-item reliability when compared to a proposed objective (days per week) response scale. Parent users provided feedback as to re-wording of many FNPA items. The second study evaluated the utility of this revised FNPA in 1st grade students and 10th grade students and showed that 1st grade children with FNPA scores in the lowest tertile were significantly more likely to be overweight/obese than 1st grade children with FNPA scores in the highest tertile. This relationship was not present in 10th grade students, although school-level socioeconomic status (SES) did influence weight in older youth. The third study demonstrated that parent weight status, race, family income, and school SES influence growth trajectories from 1st to 10th grade. A unique finding of
this study was that change in FNPA score from 1\textsuperscript{st} to 10\textsuperscript{th} grade was a significant predictor of BMI percentile and BMI50, an alternative measure of weight status, in 10\textsuperscript{th} grade.

This dissertation adds to the existing literature regarding factors that influence obesity risk during childhood and adolescence. The results provide further support for the continued use of the FNPA, utilizing the subjective response scale. Additionally, these studies highlight the influence parent weight status, race, family income, and school-level SES on weight status throughout childhood. Future research is needed to examine the FNPA in additional populations and to further examine the influence of these family- and community-level factors of obesity risk.
CHAPTER 1. INTRODUCTION

Dramatic increases in the prevalence of childhood overweight and obesity have been seen in recent decades in the United States and throughout the world (Fryar, Carroll, & Ogden, 2012; Wang, Monteiro, & Popkin, 2002). In the United States, obesity prevalence has increased by a factor of 2 to 3 (depending on the age group) from 1976 to 2010. According to data from the National Health and Nutrition Examination Survey (NHANES) 2011-2012, 8.4% of 2-5 year olds, 17.7% of 6-11 year olds, and 20.5% of 12-19 year old American children are now considered obese, based on the established age and gender specific thresholds for body mass index (BMI) (Ogden, Carroll, Kit, & Flegal, 2014). Childhood obesity has been found to track over time with associations with adult weight status strengthening as children move closer to adulthood (D. S. Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; Guo, Wu, Chumlea, & Roche, 2002; Sun et al., 2008; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). For example, a 5-year-old girl classified as obese has a 37% chance of becoming an overweight adult but the likelihood increases to 64% for an obese 12-year-old girl (Guo et al., 2002).

There are also direct clinical consequences of overweight and obesity in youth, including increased incidence of cardiovascular, metabolic, pulmonary, gastrointestinal, skeletal and psychosocial issues. Due to likelihood of metabolic abnormalities to cluster together, the term metabolic syndrome was coined to describe people who exhibit multiple such co-morbidities. Included risk factors are increased waist circumference, hypertension, increased triglyceride and decreased high-density lipoprotein (HDL) - cholesterol levels, and elevated blood sugar levels. At least three risk factors must be present for a diagnosis of metabolic syndrome. There is consensus that metabolic
syndrome is more prevalent in obese children than in normal weight children (Cook, Auinger, Li, & Ford, 2008; Kranz, Mahood, & Wagstaff, 2007; Laurson, Eisenmann, & Welk, 2011; Laurson, Welk, & Eisenmann, 2014; Messiah, Arheart, Luke, Lipshultz, & Miller, 2008; Y. Pan & Pratt, 2008). For example, Laurson and colleagues found the prevalence of metabolic syndrome to be between 19% and 35% in obese children, compared to less than 2% in normal-weight children. This well-documented clustering of comorbidities in overweight and obese children further highlights the need to prevent and treat elevated child weight status.

Various socio-demographic factors have been associated with increased risk for obesity, including race and economic status (Guerrero et al., 2015; Rossen, 2014; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2013). The most recent NHANES surveys show that obesity prevalence is lower in non-Hispanic Asian and non-Hispanic White youth than in Hispanic and non-Hispanic black youth (Ogden et al., 2014) and rates of child obesity have been found to be higher in low income populations (Phipps, Burton, Osberg, & Lethbridge, 2006). There is also evidence that obesity rates have increased more in recent years for children in low-income families, as well as for non-Hispanic black children, compared to other racial/ethnic groups and higher income samples (Anderson & Butcher, 2006). Beyond the influence of family income, the economic affluence of an individual’s surrounding community may also play a role. Research has shown that a higher family income can protect against obesity for children living in areas with low deprivation, but that this protective effect is not seen if there is high neighborhood-level deprivation (Rossen, 2014). Due to their strong and consistent influence, these are factors that must be considered in any discussion of obesity.
However, these factors do not explain the increase in obesity prevalence that has been seen in recent decades. Multiple causes have been investigated for their role in rising obesity levels, both for children and for adults, and while genetics can play a role in weight status (World Health Organization, 1997), the increase in obesity levels has been too rapid to be due to physiological changes in genetics or metabolism. Instead, the most likely culprits are changes in the social/physical environment and associated changes in lifestyle behaviors. Decreases in physical activity and sleep, increases in screen time and other sedentary activities and changes in dietary intake, including increased consumption of ‘fast food’ and sugar-sweetened beverages, have all been examined for links to weight status. In order to have a plausible link to the increase in obesity prevalence, corresponding shifts in these factors must also have been evident in the last 30 to 40 years. Indeed, Putnam and Gerrior found large increases in the consumption of sugar-sweetened beverages, specifically carbonated, non-diet soda, since the 1970s with the largest increase beginning in 1987 and continuing through the 1990s (Putnam & Gerrior, 1999). Concomitant increases in portion sizes and increased consumption of food away from home have also been implicated as having a role (Cutler, Glaeser, & Shapiro, 2003; Young & Nestle, 2002). In addition to changes in the food environment, there have been changes in the built environment that may lead to decreased energy expenditure. Urban sprawl is known to increase automobile traffic (Ewing, Pendall, & Chen, 2002) and likely plays a large role in the steep decline in children walking or riding bikes to school that has been seen in the last generation (Beldon Russonello and Steward Research and Communications, 2003). There has also been a documented increase in screen time in the last decade. A 2010 study found that 8-
18 year olds average 7 hours and 38 minutes per day, or more than 53 hours per week, of screen time (The Henry J. Kaiser Family Foundation, 2010). At the same time, children are progressively obtaining less sleep (Iglowstein, Jenni, Molinari, & Largo, 2003). The combination of all these changes has been referred to as an “obesogenic” environment that may predispose individuals to be overweight.

The obesogenic environment helps to explain the overall population patterns but ultimately individuals must navigate this environment to reduce their own individual risk. Adults can take responsibility for their own weight management practices but children’s risk is directly influenced by parenting practices, home environments and family behaviors (Arredondo et al., 2006; Kirsten Krahmstoever Davison, Cutting, & Birch, 2003; Joyce & Zimmer-Gembeck, 2009). Therefore, efforts to understand childhood obesity have focused on the impact of parenting and factors influencing the home environment.

The Family Nutrition and Physical Activity (FNPA) screening tool was developed to help identify home environments and practices that may predispose youth to obesity. As a screening tool, the key goal of the FNPA is to identify children who are at risk of becoming overweight or obese before weight begins to increase. The FNPA is a 20-item questionnaire that gathers information about physical activity, screen time, nutrition and sleep habits and has been shown to correlate with BMI and to predict one-year changes in child BMI (Ihmels, Welk, Eisenmann, Nusser, & Myers, 2009; Ihmels, Welk, Eisenmann, & Nusser, 2009). Significant correlations were found between BMI and seven of the ten constructs or topic areas of the FNPA (breakfast/family meals, modeling nutrition, high calorie beverage intake, television in the bedroom, parent physical
activity, child physical activity and sleep schedule) as well as with the overall FNPA score. In an examination of predictive utility, 704 first-graders in an urban, metropolitan school district were administered FNPA surveys and followed-up with one year later. Over half of the participants exhibited increases in BMI percentile for age and gender with the FNPA score explaining unique variance in BMI at follow-up. While the utility of the FNPA for baseline and short-term correlations with BMI, studies have not examined impact over time or compared outcomes between children and adolescents. Different formats have also been used to capture the key constructs in the FNPA but these have not been directly compared.

The FNPA has considerable promise for use in school-based screening and in clinical applications but additional work is needed to refine the tool. The series of papers presented in this dissertation will advance the research addressing the FNPA. Study 1 will examine and compare alternative formats of the FNPA, both quantitatively and qualitatively. Study 2 will compare associations between the FNPA and BMI measures in both child and adolescent samples. Finally, Study 3 will evaluate the ability of the FNPA to detect long-term risks for overweight. A comprehensive literature review is provided to summarize research on the correlates and consequences of childhood overweight and obesity as well as the background on the development and validation of the FNPA tool.
1.1 References


CHAPTER 2. LITERATURE REVIEW

2.1 Prevalence and Consequences of Childhood Overweight and Obesity

Overweight and obesity in adults is defined based on a ratio of height to weight known as the body mass index (BMI). The National Institutes of Health has established cut points of 25 kg/m\(^2\) and 30 kg/m\(^2\) to distinguish overweight and obesity, respectively, in adults. These universal cut points cannot be applied to children due to considerations for growth patterns and because the relationship between height and weight may be looser in children than in adults. However, a 1999 consensus statement of the International Obesity Task Force concluded that BMI may be a reasonable estimate of fatness in children and adolescents if adjusted for age and gender (Dietz & Bellizzi, 1999). The task force suggested the use of the 85\(^{th}\) age-and-sex percentile as a ‘screening index’ for overweight and the 95\(^{th}\) percentile for excess adiposity. These guidelines were adopted with the 85\(^{th}\) percentile representing children “at risk for overweight” and the 95\(^{th}\) percentile representing “overweight.”

In 2005, the Institute of Medicine released a report on “Preventing Childhood Obesity,” which preserved the use of the 95\(^{th}\) percentile cutoff but adjusted terminology from “overweight” to “obese”, stating that “the term ‘obese’ more effectively conveys the seriousness, urgency, and medical nature of … concern than does the term ‘overweight…” The American Medical Association, National Center for Health Statistics and Centers for Disease Control and Prevention (CDC) also adopted this new terminology with the 85\(^{th}\) percentile denoting overweight and the 95\(^{th}\) percentile denoting obesity (Krebs et al., 2007; Ogden & Flegal, 2010). Much of the reasoning for the change in terminology centered on stressing the seriousness of excess weight in children and its
connection to elevated risk factors and morbidity that the committee felt was not adequately expressed by the previous terminology. These values are widely used to classify overweight and obesity but it is important to note that the “percentile” labels do not reflect the percentage of youth at risk, but rather identify cut points at which high weight status tracks to adult overweight and obesity based on population distributions.

Regardless of the metric used, there is now incontrovertible evidence of a dramatic increase in both adult and pediatric overweight and obesity prevalence in recent decades. Results from the 2011-2012 National Health and Nutrition Examination Survey (NHANES) estimate that 68.5% of US adults are either overweight or obese, 34.9% are obese and, of these, 6.4% are classified as Grade 3 Obesity (BMI greater than or equal to 40 kg/m$^2$) (Ogden, Carroll, Kit, & Flegal, 2012b). The largest increases in prevalence in the last 30 years have occurred at the highest end of the BMI scale with prevalence of obesity increasing from 22.9% and Grade 3 obesity from 2.8% in NHANES III in 1988-1994. These trends are mirrored in children and adolescents, with increases in both boys and girls and across all age categories (2-5, 6-11 and 12-19 years old) from NHANES I in 1971-1974 through NHANES 2009-2010 (Ogden, Carroll, Kit, & Flegal, 2012a) (Table 2.1). Additionally, these increases are seen across racial/ethnic groups, although with varying severity. Larger increases in obesity prevalence have been seen in non-Hispanic Black (10.7% to 22.6%) and Mexican American boys (14.1% to 28.9%) compared to non-Hispanic White boys (11.6% to 17.5%). Prevalence rates are also higher in non-Hispanic Black girls (24.8%) and Mexican American girls (18.6%) than in non-Hispanic White girls (14.7%). Further, these increases are not limited to the United States. A 2002 review by Ebbeling and Pawlak found that, while different studies used different cut
points (i.e., age-adjusted BMI to adult 25 kg/m², age-adjusted BMI to adult 30 kg/m², >2 SD from median, > 95th percentile, > 120% of standard weight) child obesity rates had increased in all thirteen countries examined (Ebbeling, Pawlak, & Ludwig, 2002). In Scotland, obesity rates in girls ages 4-11 years increased from 1.8% in 1984 to 3.2% in 1994. In Brazil, obesity rates in 6-9 year olds increased from 2.7% in 1987 to 6.8% in 1992. And in Australia, obesity rates in girls ages 7-15 more than quadrupled from 1985 to 1996 (1.2% to 5.5%).

Certainly, with such alarming data across ages, ethnicities and countries, the trends of increasing pediatric obesity cannot be ignored. Genetic factors can have an effect on an individual’s predisposition to heavier weight status and rare genetic defects in the leptin signaling pathway as well as several other genetic syndromes (e.g. Prader-Willi syndrome) have been identified for roles in increasing adiposity (Han, Lawlor, & Kimm, 2010), but these account for a very small percentage of today’s cases of obesity. The rapid speed of the increase in obesity rates also suggests that factors beyond genetics must be involved. Low energy expenditure, poor diet, increased screen time (television, computers, video games, movies and other screen entertainment) and poor sleep hygiene, among other factors, have been the focus of a large body of research for possible causal pathways to obesity. However, numerous other factors are also involved.

The literature review will include four key sections. The first will summarize clinical health risks associated with overweight status in youth. The second will summarize the literature on key behavioral factors shown to predict children’s risk of becoming overweight. The third section will describe the unique and important impacts of parenting styles, behaviors, and home environments on shaping children’s risk for
becoming overweight. The final section will provide a background of the development
and validation of the Family Nutrition and Physical Activity (FNPA) screening tool to
establish a context for the studies proposed in this dissertation.

2.2 Clinical Health Risks Associated with Overweight in Youth

In adults, overweight and obesity are known to correspond with a number of
comorbidities including hypertension, high serum cholesterol and diabetes mellitus
(Paeratakul, Lovejoy, Ryan, & Bray, 2002). The recent trends in pediatric overweight and
obesity are especially concerning if they coincide with increased prevalence of these
comorbidities that were previously thought of as adult ailments. Data from the large,
longitudinal Bogalusa Heart study shows that the percentage of children with multiple
risk factors increases with increasing BMI-for-age and levels of excess adiposity
(Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). There is strong evidence that
high weight status in youth correlates with high blood pressure as well as longitudinal
evidence of an increasing prevalence of pediatric hypertension over the same time period
in which increasing prevalence of pediatric obesity has been observed (Din-Dzietham,
Liu, Bielo, & Shamsa, 2007; Rosner, Cook, Daniels, & Falkner, 2013).

Childhood obesity is known to contribute to increases in blood pressure both in
childhood and into adulthood (Falkner et al., 2006; Field, Cook, & Gillman, 2005; He,
Ding, Fong, & Karlberg, 2000; Paradis et al., 2004; Sabo, Lu, Daniels, & Sun, 2012).
Falkner et al. found significant increases in systolic and diastolic blood pressure with
increasing weight status (<85th%, 85th-94th%, ≥95th%) across all ages from 2 to 19 years
of age suggesting that the effects of obesity on blood pressure begin early (Falkner et al.,
2006). A one-standard deviation increase of BMI at age 7 is associated with increased
odds (OR 1.10, 95% CI 1.04, 1.17) of hypertension at age 45. A similar increase in BMI at age 11 increases risk of hypertension by 22% (95% CI 1.15 – 1.28) (Li, Law, & Power, 2007). These recent trends highlight the need to identify children who may be at risk for developing overweight or obesity in order to avoid health complications in childhood and into adulthood.

Utilizing the electronic medical record (EMR) of over 18,000 children between ages 2 and 19, Falkner et al. found that there are significant increases in both systolic and diastolic blood pressure with increasing BMI (p < 0.001)(Falkner et al., 2006). These associations were found across all age groups (2-5, 6-10, 11-15, and 16-19 years) and in both boys and girls. High weight status (Quetelet Index >95 P) increases odds of high systolic blood pressure by 450% (OR 3.6-5.8) and increases odds of high diastolic blood pressure by 240% (OR 1.8-3.0) (Freedman, Dietz, Srinivasan, & Berenson, 1999). Effects of increasing weight on blood pressure have been found in both obese and normal-weight children, suggesting that high blood pressure can manifest before obesity (He et al., 2000). This increase in blood pressure may manifest as diagnosable hypertension, or as smaller increases in blood pressure that remain within the normal range. In a sample of over 2000 children, prevalence of high blood pressure in obese children was 48% compared to 41% in overweight children and 21% in normal-weight children (McGavock, Torrance, McGuire, Wozny, & Lewanczuk, 2007). Similar results showing associations between weight status and blood pressure have been found by many other investigators (Paradis et al., 2004; Reich et al., 2003; Ribeiro et al., 2003; Schiel, Beltschikow, Kramer, & Stein, 2006).
Utilizing NHANES data, Muntner and colleagues found evidence that average systolic and diastolic blood pressure increased from 1988 to 2000 (Muntner, He, Cutler, Wildman, & Whelton, 2004). The increase in systolic blood pressure was significant in boys and girls and stronger in non-Hispanic Blacks and Mexican Americans than non-Hispanic Whites. More significant increases in both systolic and diastolic blood pressure were found in 8-12 years olds than in 13-17 year olds. Age-specific prevalence of pediatric hypertension appeared to decrease from 1963 to 1988 but increased from 1988 to 2002, according to NHANES data (Din-Dzietham et al., 2007). Prevalence of pre-hypertension increased in both male and female non-Hispanic Blacks and Mexican Americans across this time span, with non-significant increases in non-Hispanic Whites. Prevalence of hypertension increased in female non-Hispanic Whites and both male and female Mexican Americans.

One of the main concerns for the increasing prevalence of child overweight and obesity is the impact of high weight status in childhood on adverse outcomes in adulthood. Excess weight in childhood has been shown to be predictive of hypertension in adulthood. Children at or above the 85th percentile for BMI between age 8 and 15 are five times more likely to develop hypertension in the following decade (OR 5.1, 95% CI 1.4-18.1)(Field et al., 2005). Li and colleagues have reported on BMI and blood pressure trends in a large cohort (original n = 17,000), including follow-up time points at 7, 11, 16, 23, 33, 42, and 45 years of age (Li et al., 2007). BMI and incidence of overweight/obesity at every time point was found to be predictive of hypertension at age 45, with the strength of association generally increasing with each subsequent time point. Blood pressure is just one of the comorbidities that may occur with increased weight status. The metabolic
syndrome has been defined as a clustering of 3 or more factors that exceed criterion values including high waist circumference, systolic blood pressure, diastolic blood pressure, fasting plasma triglycerides, fasting plasma high-density lipoprotein cholesterol, and fasting plasma glucose. Differences in BMI are seen as early as age 8 for males who eventually do vs. do not develop metabolic syndrome and around age 13 in females (Sun et al., 2008).

The incidence of T2DM in adolescents increased by over 30% from 2001 to 2009, in parallel to the increased incidence of child obesity (Dabelea et al., 2014) and research has consistently shown increased risk for diabetes in individuals who were overweight as children (Al Mamun, Cramb, O’Callaghan, Williams, & Najman, 2009; Freedman et al., 1999; Must, Jacques, Dallal, Bajema, & Dietz, 1992; Reilly & Kelly, 2011). However, in a review of four large cohort studies, Juonala et al. found that individuals who were overweight as children but normal weight as adults were not at any increased risk for T2DM, elevated low-density lipoprotein (LDL) -cholesterol or total cholesterol, or low HDL-cholesterol, suggesting that adverse effects are reversible (Juonala et al., 2011).

Obese children are also at increased risk for obstructive sleep apnea syndrome (OSAS) and nonalcoholic fatty liver disease (Arens & Muzumdar, 2010; Daniels, 2006). OSAS occurs in approximately 2% of the general pediatric population, but obese children are nearly five times as likely to experience sleep-disordered breathing (OR 4.69, 95% CI 1.59-14.15) (Redline et al., 1999) and as many as 50% of obese children may have fat deposits in their livers (Kinugasa et al., 1984). The incidence of OSAS increases to 33% in severely overweight youth (Mallory, Fiser, & Jackson, 1989).
2.3 Factors Influencing Pediatric Obesity

Considerable research has been done to try to identify factors that may predispose youth to becoming overweight. The most common, preventable factors include physical activity (or lack thereof), screen time, nutrition and sleep hygiene. The following section will discuss the existing research into the independent and synergistic influences of these factors on pediatric obesity.

2.3.1 Physical Activity

Physical activity is a vital component of the energy balance model and so has an implied link to obesity. Recent studies on secular trends have produced mixed evidence of children and adolescents’ participation in moderate-to-vigorous physical activity, both through structured physical education classes and in unstructured play. Lowry and colleagues found that participation in physical education classes at least 5 times per week in the United States decreased from 42% to 28% between 1991 and 1997 (Lowry, Wechsler, Kann, & Collins, 2001). Results from the national Youth Risk Behavior Surveillance System (YRBSS) show no significant changes in the prevalence of having attended physical education classes from 1991-2013 (Centers for Disease Control and Prevention, 2014). There has been little change in participation in at least one team sport from 1999 to 2013 (55.1% to 54.0%), as reported by the YRBSS. Ekelund, Tomkinson and Armstrong conducted a review of self-reported physical activity in youth and found that while only 30-40% of youth are sufficiently active, there is not conclusive evidence that physical activity in young people has declined in recent decades (Ekelund, Tomkinson, & Armstrong, 2011). However, many surveillance systems with the ability to track these changes over time rely on self-report measures that may lack the precision
needed to accurately assess behavior. More objective measures may be needed to capture small changes across time.

While the evidence of a systematic decrease in youth physical activity is ambiguous, there is evidence for an existing relationship between levels of physical activity and weight status. Using doubly-labeled water and accelerometry, Abbott and Davies found significant inverse correlations between vigorous activity levels and body fat percentage ($r = -0.44$, $p = 0.004$) in 5 to 10 year old children (Abbott & Davies, 2004). Results from the European Youth Heart Study also support a relationship between moderate and vigorous activity, assessed by accelerometry, and body fat ($\beta = -0.0019$, $p = 0.04$) and vigorous activity only and body fat ($\beta = -0.0034$, $p = 0.02$) (Ekelund et al., 2004). Other studies using accelerometry, pedometers and direct observation to assess physical activity have found similar results (Laurson et al., 2008; Ortega, Ruiz, & Sjöström, 2007; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). Laurson et al. measured habitual free-living activity with pedometers and found that boys who accumulated fewer than 13,000 steps per day were 2.74 times more likely to be overweight than those who achieved at least 13,000 steps (95% CI 1.54-4.88). Girls who took less than 11,000 steps per day were 2.37 times more likely to be overweight than those who met this recommendation (95% CI 1.50-3.75). Ortega et al. examined a sample of over 1000 Swedish children and adolescents and found that physical activity levels as measured by accelerometry were associated with overweight (Ortega et al., 2007). Youth in the lowest tertile of physical activity were more than twice as likely to be overweight (OR 2.7, 95%CI 1.2-6.4) compared to those in the highest tertile of physical activity. Similar to
other results, the strongest relationship was found between overweight and vigorous physical activity (>6 METS) (OR 4.1, 95% CI 1.8-9.5).

Longitudinal and intervention studies have also found an effect of physical activity on overweight. Moore et al. examined data from the Framingham Children’s Study to evaluate the effects of physical activity on adiposity from age 4 to age 7 (Moore et al., 2003). Physical activity levels were examined at baseline, individual time points and as an average across all time points. At baseline, no significant differences in BMI were found between children based on tertiles of physical activity. Children in the highest tertile of average activity across all time points had significantly lower mean BMI, triceps skinfold and sum of five skinfolds at the end of follow-up compared to the lowest tertile of activity. Jago et al. examined the effects of physical activity, television viewing and diet on BMI over 3 years in a cohort of Anglo-American, African American and Hispanic 3-4 year olds (Jago, Baranowski, Baranowski, Thompson, & Greaves, 2005) and found that heart rate-measured physical activity per hour was a significant predictor of BMI ($\beta = 7.667, p = 0.003$).

2.3.2 Screen Time

Lack of physical activity may occur partially due to time use being replaced by sedentary, screen media activities, but there is evidence that sedentary behavior is independent of physical activity and may have independent risks for overweight. The recent trends showing increased screen time exposure for children are certainly consistent with the patterns of increased overweight status. A 2010 study by the Kaiser Foundation examined media use trends (The Henry J. Kaiser Family Foundation, 2010). From 1999 to 2009, average television time per day among 8- to 18-year-olds increased from 3.47
hours to 4.29 hours. Computer use increased by over an hour per day (27 minutes in 1999 to 1:29 in 2009) and video games increased by 47 minutes (26 minutes to 1:13). The combination of television, music content, computer, video games, print and movies shows an increase in total media exposure from 7:29 to 10:45 per day when multi-tasking in taken into account. Approximately 99% of 8-18 year old report the presence of at least one television in their home, 86% have computers in their homes, including 74% with internet access, and 83% have some type of video game system.

Research from the early 2000’s showed a relationship between increased television viewing and increased odds of overweight and obesity (Crespo et al., 2001; Dennison, Erb, & Jenkins, 2002). Data on over 4,000 children from NHANES III showed the lowest prevalence of obesity in children who watched 1 or fewer hours of television per day and the highest prevalence among those who watched 4 or more hours per day. This relationship persisted after controlling for physical activity and energy intake. These data are supported by examination of the relationship between television/video viewing time and odds for overweight (>85th age- and sex-specific percentile) in a large sample of low-income children recruited through agencies of the Supplemental Nutrition Program for Women, Infants and Children (WIC)(Dennison et al., 2002). In this sample, every hour of television viewing per day increased the odds of overweight by 6%. In a study of nearly 3000 children, the odds of being overweight and obese generally increased with increasing television viewing but this relationship was not found for video game/computer use (Wake, Hesketh, & Waters, 2003). However, the effect of television viewing was rendered non-significant after adjustment for maternal and family characteristics, diet and physical activity level. In a meta-analysis conducted by Marshall
et al. in 2004, the sample-weighted, corrected effect size between TV viewing and body fatness was 0.084 (95% CI 0.06-0.08), suggesting a significant but small relationship between TV time and adiposity (Marshall, Biddle, Gorely, Cameron, & Murdey, 2004). This relationship was non-significant between video/computer games and adiposity (95% CI -0.05 to 0.19). Significant but small effect sizes were found for TV viewing and physical activity (d = -0.080 to -0.112) and video/computer game use and physical activity (d = -0.090 to -0.128). Grund et al. also found a positive relationship between TV viewing and fatness although TV viewing time did not correspond with reduced 24-hour energy expenditure (Grund, Krause, Siewers, Rieckert, & Müller, 2007).

Despite consistent associations between screen time and weight status, this effect may not be independent of physical activity. A review by Pate and colleagues found generally null associations between sedentary time and physical activity (Pate, Mitchell, Byun, & Dowda, 2011), suggesting that children with high amounts of screen time or other sedentary activities do not necessarily have less physical activity than their peers who accumulate less screen time. Others have found no effect of screen time on body composition and metabolic health after controlling for physical activity levels (Chaput et al., 2012; Ekelund et al., 2006, 2012; Must et al., 2007), suggesting that youth with high levels of sedentary activity are not any more likely to be overweight if they are still physically active.

Various studies have shown that children who meet recommendations for both physical activity and screen time are less likely to be overweight than those meeting only one or neither of these recommendations. In a sample for 7-12 year olds, girls who met neither physical activity recommendations (11,000 steps per day) nor screen time
recommendations (≤ 2 hours per day) were three times as likely to be overweight compared to girls meeting both requirements (95% CI 1.44-6.26) (Laurson et al., 2008). This relationship was stronger in boys (OR 4.39, 95% CI 1.47-13.12). Anderson et al. found that boys who watched the highest amounts of television and completed the fewest bouts of vigorous activity had the highest sum of trunk skinfolds, but that the overall relationship with weight and adiposity was higher for screen time than for physical activity (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998). Using YRBSS data, Eisenmann et al. found that girls in the highest tertile of television viewing and lowest tertile of vigorous physical activity were over three times as likely (OR 3.11, 95% CI 1.41-3.04) to be overweight/obese compared to girls in the lowest tertile for TV and highest tertile for vigorous activity (Eisenmann, Bartee, Smith, Welk, & Fu, 2008). This relationship was not significant for boys, although similar results were found for both boys and girls when examining television time and moderate physical activity.

The availability of screens in the bedroom may also play a role in obesity trends. An estimated 68% of 8- to 18-year-olds now have televisions in their bedrooms while 31% and 49% have a computer or video game system, respectively. The presence of a television in the bedroom has been associated with excessive screen time in 6- to 11-year olds (OR 1.7, 95% CI 1.4-2.1) and 12- to 17-year-olds (OR 1.4, 95% CI 1.2-1.6) (Wethington, Pan, & Sherry, 2013). The combination of more than 2 hours of screen time per day and a television in the bedroom more than doubles the odds of a child being obese (OR 2.5, 95% CI 1.9-3.2). Chahal et al. found that the odds of obesity were increased by the availability of a computer (OR 1.47, 95% CI 1.09-1.98) or tv/dvd/video games (OR 1.60, 95% CI 1.21-2.11) in the bedroom and that the availability of multiple
electronic entertainment devices led to an escalation of these risks (Chahal, Fung, Kuhle, & Veugelers, 2012). Similar effects of television in the bedroom on overweight and overall screen time were also found by Dennison and Tandon (Dennison et al., 2002; Tandon et al., 2012). Rapidly advancing technology has created a myriad of options for screen time including laptops, cell phones, tablets, Kindles™, iPods™ and more, making it even harder to measure and monitor screen time. And while television viewing is often used as a proxy for sedentary time, it is important to note that not all screen time is sedentary and not all sedentary time is screen time.

### 2.3.3 Sleep

The association between screen time and obesity may be complicated by the effect of screen time on sleep habits. A longitudinal study including children from two separate Midwestern communities found that media exposure predicted body mass index thirteen months later but that the association was mediated by sleep time measured 7 months after baseline (Barlett, Gentile, Barlett, Eisenmann, & Walsh, 2012). The availability of media (tv, dvd, video games, computer, cellular phone) in the bedroom has been found to be associated with sleep duration and overweight and obesity in 5th grade students (Chahal et al., 2012).

Independent of the impact on screen time, there is overwhelming evidence that decreased sleep contributes to increased weight status. In a sample of 4452 10- to- 12 year olds, children obtaining more than 10 hours of sleep per night had a 30% lower risk of obesity than those obtaining less than 9 hours per night (OR 0.70, 95% CI 0.49-0.99) (Wells et al., 2008). In a sample of younger children (7-years old), less than 9 hours of sleep per night was associated with over three times the odds (OR 3.32, 95% CI 1.40-
7.87) of being overweight/obese and an increase of 3.34% body fat \((p = 0.03)\), independent of screen time and physical activity (Nixon et al., 2008). Similar results have been found by many others (Chaput, Brunet, & Tremblay, 2006; Chen, Beydoun, & Wang, 2008; Joey C Eisenmann, Ekkekakis, & Holmes, 2006; Jong et al., 2012; Pileggi, Lotito, Bianco, Nobile, & Pavia, 2013; von Kries, Toschke, Wurmser, Sauerwald, & Koletzko, 2002). The impact of sleep on obesity may be impacted by sleep quality, timing of sleep and the effect of late sleep on nutrient intake. Late bedtimes have been tied to shorter sleep times, as children often have a set wake-time so that they can be to school on time (Jong et al., 2012). Poorer sleep quality, more sleep disturbances and delayed sleep are associated with increased adiposity and body composition in children and adolescents, independent of sleep duration (Jarrin, Mcgrath, & Drake, 2013). Adamo et al. found that late sleepers (adolescents with a midpoint of sleep at or later than 3:30am) had higher daily caloric intake independent of physical activity and sleep duration (Adamo, Wilson, Belanger, & Chaput, 2013).

The association between sleep and obesity has also been examined longitudinally, with similarly strong associations found. Utilizing a national sample, Lumeng et al. found that short sleep duration in 3rd grade was associated with overweight in 6th grade and this association was independent of child weight status in 3rd grade and independent of maternally reported sleep problems (insomnia, night waking, restlessness)(Lumeng et al., 2007). Snell et al. also found that, independent of baseline BMI, shorter sleep duration, later bedtime and earlier wake time were associated with overweight after a 5-year follow-up (Snell, Adam, & Duncan, 2007). Persistently short sleep duration at age 2.5 has been found to significantly increase the risk of excess weight at 6 years of age (Touchette
et al., 2008). The importance of sleep may be especially high during childhood as short sleep duration in childhood has been associated with BMI in adulthood even when controlling for adult sleep time (Landhuis, Poulton, Welch, & Hancox, 2008). Importance of sleep duration has been shown as early as infancy. Sleep duration of less than 12 hours during infancy predicts increased odds of obesity at age 3 compared to infants obtaining at least 12 hours per night, even when accounting for maternal factors and birth weight (OR 1.94, 95% CI 1.04-3.64), maternal factors, birth weight and television viewing (OR 1.96, 95% CI 1.03-3.73), and maternal factors, birth weight, television viewing and active play (OR 2.04, 95% CI 1.07-3.91) (Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008).

2.3.4 Nutrition

Total energy intake by American children increased by 179 calories per day from 1977 to 2006 and a majority of this increase can be attributed to the rise in calories consumed away-from-home (+255 kcal/day)(Poti & Popkin, 2011). Fast food has surpassed school foods as the main source of foods consumed away-from-home for all age groups of children. Bowman et al. reported that over 30% of 4-19 year old children surveyed (total sample 6212) reported consuming fast food in the last 24 hours (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004). Provision of meals via fast food has been shown to result in increased total fat, saturated fat, carbohydrate, added sugars and non-diet carbonated beverages as well as decreased intake of fiber, fluid milk and fruits and non-starchy vegetables (Bowman et al., 2004). Jeffery et al. found that eating fast food was associated with higher BMI, lower vegetable consumption, and lower physical activity, although proximity to fast food was not associated with eating fast food or with
BMI (Jeffery, Baxter, McGuire, & Linde, 2006). The CARDIA study followed over 3000 subjects for 15 years and found that changes in fast-food frequency were directly associated with changes in weight and insulin resistance (Pereira et al., 2005). Increased frequency of fast food consumption predicts weight gain during the transition from adolescence to adulthood (Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006). Research also suggests that adolescents who are already overweight may not regulate overall energy intake throughout the day to compensate for high energy intake from fast food consumption (Bowman et al., 2004).

Many attempts to curb the pediatric obesity epidemic have targeted sugar-sweetened beverages (SSB) and research shows some evidence for prevention and treatment of weight gain by replacing SSB with sugar-free beverages in children and adults (Ebbeling et al., 2012; Ruyter, Olthof, Seidell, & Katan, 2012). Intake of SSB has been associated with overweight/obesity development over a 5-year follow-up period (Tam et al., 2006) and SSB consumption at age 5 has been found to be positively associated with adiposity from age 5 to age 15 (Fiorito, Marini, Francis, Smiciklas-wright, & Birch, 2009). A systematic review of prospective cohort studies and randomized controlled trials performed by Malik and colleagues found good evidence that SSB consumption promotes weight gain in children, as well as adults (Malik, Pan, Willett, & Hu, 2013). The included studies were published between 2001 and 2012 and suggested that a 1-serving per day increase in SSBs was associated with a 0.06-unit increase in BMI over a one-year period in children and adolescents. De Ruyter et al. also found that sugar-free beverages resulted in the same level of satiety in children as SSB, suggesting that sugar-free beverages could be substituted for SSB without a
compensatory increase in caloric intake elsewhere to achieve satiety (de Ruyter, Katan, Kuijper, Liem, & Olthof, 2013).

Increased intake of SSB is especially concerning if these beverages are consumed instead of milk or other dairy products. A longitudinal study of over 2000 girls shows that consumption of milk decreases and consumption of regular soda increases as girls age from 9 to 18 years of age. A number of studies have found an inverse association between dairy consumption and weight status (Barba, Troiano, Russo, Venezia, & Siani, 2005; Carruth & Skinner, 2001; L. Johnson, Mander, Jones, Emmett, & Jebb, 2007; Louie, Flood, Hector, Rangan, & Gill, 2011; Moore et al., 2006; Novotny, Daida, Acharya, Grove, & Vogt, 2004; Striegel-Moore et al., 2006). However, others have found no association (Fiorito et al., 2009; Huh, Rifas-Shiman, Rich-Edwards, Taveras, & Gillman, 2010; Newby et al., 2004; Phillips, Bandini, Cyr, Naumova, & Must, 2003; Tam et al., 2006). Caution must be taken when considering the benefits of dairy if it is consumed as flavored milk as associations between flavored milk consumption and increased body fat have been found (Noel, Ness, Northstone, Emmett, & Newby, 2013).

### 2.4 Family Components of Obesity

While indicators of health in adults are often assessed and determined at the individual level, children are greatly influenced by their parents and the economic position of their family. General parenting style as well as specific parenting practices related to health influence a child’s health opportunities and behaviors. These opportunities and behaviors may be helped or hindered by the family’s socioeconomic
status. This section will examine parental influence, parenting style and the moderating influence of socio-economic status on child weight status.

2.4.1 Parental Influence

The associations of physical activity, sleep, screen time and nutrition with weight status suggest that parents must be actively involved in helping their children make healthy choices in these areas to avoid adverse outcomes. While adults can make their own decisions, youth behaviors are directly determined by parenting behaviors and practices. Young children cannot be expected to know of the associations between their behaviors and health or to make their own decisions to control these behaviors so parents are often expected to be the agents of change. Parents exert a large amount of influence on child behaviors including physical activity, screen time, sleep and nutrition because of their role as gatekeeper and role model to their children. Davison and colleagues suggested a specific model of the Ecological Systems Theory to illustrate how these factors are influenced by parenting styles and family characteristics (Figure 2.1) (Davison, Jurkowski, & Lawson, 2012). Parents influence physical activity by modeling it themselves and through the opportunities and encouragement for physical activity they provide to their children. Parents create home rules (or lack thereof) for screen time, bedtime and bedtime routines, including use of electronic media in the child’s bedroom. Parent knowledge of and access to healthy foods due to education, employment and income affect the foods that are available to the child at home. Parent child-feeding practices influence a child’s relationship to and view of foods. These specific influences are discussed in more detail below.
Research into parenting behaviors has identified three distinct parenting styles (Authoritarian, Authoritative and Permissive) and links between these parenting styles and healthy behaviors. Baumrind defined these three parenting styles in 1966 (Baumrind, 1966) and these definitions have been used in most of the subsequent research into parenting in many arenas and certainly in studies of health behaviors. The permissive parent is acceptant and affirmative toward child desires and actions and consults his/her child about decisions. This parent exerts little overt power. The authoritarian parent attempts to control child behavior and attitude with high levels of authority and restriction and is often stern. Authoritative parents attempts to direct child behavior with a balance of reason and power and encourage both autonomy and discipline in their children. A fourth parenting style of neglectful or uninvolved has also been suggested (Berge, Wall, Loth, & Neumark-Sztainer, 2010; R. Johnson, Welk, Saint-Maurice, & Ihmels, 2012). These parenting typologies can be expressed by the two dimensions of responsiveness and demandingness (Table 2.2). Several studies have examined the association between these parenting styles and body mass index. Authoritative parenting is often found to relate to lower child BMI (Sleddens, Gerards, Thijs, de Vries, & Kremers, 2011) while authoritarian parenting may be associated with higher BMI (Berge et al., 2010; R. Johnson et al., 2012).

While general parenting style has been tied to child weight status, parenting can also be measured in specific, situational behaviors and research has also examined the association between these specific parenting behaviors and child weight status. While not always the case, these specific behaviors may cluster under general parenting styles. Hubbs et al. found that authoritative parents display higher levels of responsibility,
monitoring and modeling and lower levels of restriction, while Authoritarian parents exhibited more restriction and pressuring to eat and less monitoring (Hubbs-Tait, Kennedy, Page, Topham, & Harrist, 2008). Davison and Birch (Davison & Birch, 2002) measured factors of parent physical activity and dietary patterns to identify obesogenic and non-obesogenic families. Girls from obesogenic families had higher BMI and percent body fat at age 7 and greater increases in these measures from age 5 to 7 years than girls in non-obesogenic families. Parental support for and modeling of physical activity has also been shown to correlate with higher levels of physical activity in 9-year-old girls (Davison et al., 2003). These studies suggest that parents may act as ‘gatekeepers’ by modeling healthy behaviors and providing opportunities for healthy activities to their children.

Much of the research into parenting behaviors has focused on the use of restriction. High parental control and restriction of foods has been shown to relate to higher child BMI and unhealthy eating (Arredondo et al., 2006; Joyce & Zimmer-Gembeck, 2009) while pressure to eat has been shown to correlate with lower BMI z-scores but also with increased consumption of sweets and decreased consumption of fruits (Blissett & Haycraft, 2008; Vereecken, Legiest, De Bourdeaudhuij, & Maes, 2009). However, from cross-sectional studies, it is difficult to know if restrictive practices truly lead to weight increases or if these practices develop as a reaction to child eating and weight. Sparks et al. showed the highest child BMI z-scores in children with high disinhibition and parents who practiced high restriction, suggesting that restriction may be a reaction to child disinhibited eating (Sparks & Radnitz, 2013). In 2007, Clark and colleagues conducted a review of literature on child-feeding strategies and found that
restrictive behaviors were positively associated with dietary intake and child weight (Clark, Goyder, Bissell, Blank, & Peters, 2007). Mother’s restriction of eating, as well as pressure to eat, has also been associated with a higher fat diet (Lee, Mitchell, Smiciklas-wright, & Birch, 2001). Birch and Fischer used structural equation modeling and showed that mothers’ perceptions of their daughters’ risk for overweight predicted restriction of daughters’ eating, which subsequently predicted daughters’ food intake (Figure 2.2)(Birch & Fisher, 2000). Using a longitudinal model, Faith et al. found that restrictive practices at age 3 predicted increased BMI z-score at 7 years of age (Faith et al., 2004). Fisher and Birch also found that daughters of parents who practice restriction of access to food at age 5 show increased likelihood to eat in the absence of hunger (EAH) at age 7 (Fisher & Birch, 2002). This increase in EAH has also been linked to increased BMI change from age 5 to 9 year of age, with the largest increases in EAH in girls who were already overweight and with parents who exhibited restrictive feeding practices (Francis & Birch, 2005). It is possible that parental restriction, as well as pressure to eat, reduce a child’s ability to monitor internal hunger cues to affect child energy intake and weight status.

There is additional evidence that family functioning may vary between families of obese children and families of normal weight children. Mendelson, White and Schliecker found that obese girls rate their families lower on measures of cohesion, expressiveness and democratic family style (Mendelson, White, & Schliecker, 1995), while others have found that mothers of obese children are more likely to display maternal attitudes that foster dependency of the child on the mother and manifest higher levels of maternal control over child activity (Trombini et al., 2003). A wide range of family factors were
examined in an evidence analysis conducted in the early stages of development of the Family Nutrition and Physical Activity screening tool and many of these characteristics, along with aspects of physical activity; food, nutrition, and eating behaviors; and social influences, were shown to be linked to child psychological and behavioral characteristics as well as to child weight (Figure 2.3).

2.4.2 Sociodemographic Indicators

Indicators of family or parental socioeconomic status (SES), such as family income, neighborhood deprivation, and food insecurity, have been shown to be indicative of child weight status. Rates of child obesity have been found to be higher in the poor than in non-poor children (Phipps et al., 2006). Individuals living in more rural areas and in areas that report high levels of distress show higher prevalence of childhood obesity (Bailey-Davis, Horst, Hillemeier, & Lauter, 2012). There is also evidence that obesity rates have increased more for children in low-income families, as well as for non-Hispanic black children than in other demographics (Anderson & Butcher, 2006). Income may be especially important in very early life, when families are dealing with the added stressors of a new child. Longitudinal data from the US Panel Study of Income Dynamics shows that, for families with an income below $25,000, increasing income during prenatal and birth years is associated with a decrease in adult BMI (OR -2.51, 95% CI -4.03 - -0.99). This effect was no longer significant when examining income when the individual was 1-5 years old or 6-15 years old(Ziol-Guest, Duncan, & Kalil, 2009).

In addition to family income, the overall socioeconomic status of a neighborhood or community may influence obesity risk. In a large study of Canadian youth, both
individual-level SES (material wealth and perceived family wealth) and area-level SES (unemployment rate, percentage of adults with less than a high school education, and average head-of-house employment income) were associated with increased risk for obesity (Janssen, Boyce, Simpson, & Pickett, 2006). A large sample (n = 17,000) of 2-18 year olds from NHANES 2001-2010 was used to examine the relative influences of individual- and neighborhood SES. Among youth from low-deprivation neighborhoods, high family income was protective against the increased odds of obesity seen in low-income children, but in high-deprivation neighborhoods, this protective effect was not seen, suggesting that family income only goes so far. Kimbro and Denney found similar results with increased risk for child obesity in neighborhoods with higher levels of poverty and lower levels of education, after considering individual factors (Kimbro & Denney, 2013).

There is some evidence that the influence of income on obesity may work through food insecurity. That is, families with lower incomes may experience more food insecurity, which may impact diet habits and nutritional quality and lead to overweight. Food insecurity has been associated with obesity among adults with higher prevalence of overweight among food insecure adults (35.1%) than among food secure adults (25.2%) (L. Pan, Sherry, Njai, & Blanck, 2012). In children, food insecurity, when accompanied by hunger, was positively associated with overweight compared to food secure families (OR 1.49, 95% CI 1.06 2.10) (Metallinos-Katsaras, Sherry, & Kallio, 2009). Persistent food insecurity may also be associated with obesity (Metallinos-Katsaras, Must, & Gorman, 2012). Two reviews on the association between food insecurity and child obesity conducted in 2011 independently concluded that while there are mixed results on
this topic, possibly due to underpowered studies, the two conditions do seem to co-exist. That is, while significant associations are not always found, rates of overweight and obesity are high in food-insecure children (Eisenmann, Gundersen, Lohman, Garasky, & Stewart, 2011; Larson & Story, 2011).

There also appear to be discrepancies in overweight and obesity prevalence by racial/ethnic groups. Data from NHANES 2011-2012 illustrate these differences in adults. In adults over age 20, prevalence of overweight/obesity was found to be higher in non-Hispanic Blacks (76.3%) and Hispanics (77.1%) than for non-Hispanic Whites (68.5%). Approximately 48% and 42% of non-Hispanic Blacks and Hispanics, respectively, were found to be obese, compared to 33.4% of non-Hispanic whites (Ogden et al., 2014). Similar trends were seen in children and adolescents. The prevalence of obesity was higher in non-Hispanic Blacks and Hispanics than in non-Hispanic whites in every age group (Table 2.3).

2.5 The FNPA: Uses and Future Directions

The Family Nutrition and Physical Activity (FNPA) screening tool was developed to help identify parenting practices and environments that may predispose youth to becoming overweight. As described above, numerous studies have shown that families play a key role in shaping a child’s lifestyle behaviors and their risk for becoming overweight.

The FNPA tool was developed by Iowa State University researchers, in collaboration with the Academy of Nutrition and Dietetics. It was based directly on the results of a comprehensive evidence analysis of modifiable factors found to consistently
and strongly predict a child’s risk for becoming overweight (Ihmels et al., 2007). The evidence analysis included examination of four topics for their influence on child adiposity. These topics included physical activity, sport participation, television viewing and video games and specific questions were posed for each of these topics. A literature search was conducted and approximately 80 articles were reviewed. Conclusion statements and evidence summaries were devised and strength of evidence grades were assigned to encompass quality, quantity, consistency and generalizability of findings (Appendix D). From this evidence analysis, ten constructs were formulated which are included in the FNPA (Appendix E).

The original FNPA was a 21-item questionnaire evaluating ten established constructs, or topic areas, identified by the evidence analysis. Initial validation was performed in a sample of 854 first grade children and their parents from 37 of 39 elementary schools in a large Midwestern urban school district (Des Moines, IA) (Ihmels, Welk, Eisenmann, & Nusser, 2009). Anthropometric data were obtained by trained school nurses and parents completed the FNPA survey. Correlational analysis and logistic regression were used to examine associations among FNPA factors and the relationship between these factors and child weight status. Significant correlations were found between BMI and seven of the ten constructs (breakfast/family meals, modeling nutrition, high calorie beverage intake, television in the bedroom, parent physical activity, child physical activity and sleep schedule) as well as between BMI and the overall FNPA score.

The predictive validity of the FNPA tool was examined using a longitudinal design in a large sample of youth. A one-year follow-up was conducted with the original
validation sample of urban elementary school children (Ihmels, Welk, Eisenmann, Nusser, et al., 2009). Anthropometric measurements were repeated by school nurses one year later and change in BMI percentile was calculated. Over half of the participants exhibited increases in BMI percentile with the FNPA score explaining unique variance in BMI at follow-up ($\beta = -0.017$), suggesting that an increase of 10 points on the FNPA corresponds to a decrease of 0.17 BMI units. While the independent effect of the FNPA score is small, it does suggest an impact of modifiable home environment factors.

The FNPA has also shown cross-sectional utility for identification of children with cardiovascular disease (CVD) risk factors. Yee and colleagues assessed BMI, percent body fat, waist circumference, total cholesterol, HDL cholesterol and resting blood pressure and created a continuous cardiovascular disease (CVD) risk score (total cholesterol to HDL ratio, mean arterial pressure and waist circumference) in a sample of 119 5th grade students (Yee, Eisenmann, Carlson, & Pfeiffer, 2011). The total FNPA score was significantly correlated with adiposity measures and the continuous CVD risk score, but not with cholesterol measures or mean arterial pressure. FNPA scores have also been found to be significantly lower in children with Acanthosis Nigricans, an indicator of glucose intolerance (Yee et al., 2015), providing additional support for the utility of the FNPA as a screening tool for adverse health status.

The FNPA has also been shown to be associated with parenting style. Johnson et al. examined relationships between the FNPA and the Parenting Styles and Dimensions Questionnaire (PSDQ) (R. Johnson et al., 2012). Parents were assigned to one of three clusters based on responses on the PSDQ and differences in FNPA between these clusters were assessed. Parents in the Permissive/Authoritarian cluster exhibited the lowest FNPA
scores (indicative of an obesogenic home environment) and the highest child BMI percentile scores compared to parents in the Authoritative and Authoritarian/ Authoritative clusters. Further, the FNPA has demonstrated utility as a clinical counseling tool. Christison and colleagues administered the FNPA as part of a behavior change intervention utilizing motivational interviewing approaches in primary care. They assessed both patient and provider perceptions of the tool and found good acceptability in both groups. Parents that used the FNPA to help set behavior change goals reported 68% success of meeting those goals one month later and 46% at 6 months.

While the utility of the FNPA for baseline and short-term correlations with BMI has been shown, the tool has undergone some revision and may need to be updated. The current tool consists of 20 questions, all answered on a 4-point Likert scale. The current response scale of “never/ sometimes/ often/ always” may be difficult for some parents to interpret. Certain question items have been changed, been eliminated or added since the original validation study and these may change the utility of the tool. Additionally, longer-term follow-up has not been conducted with the FNPA. The FNPA is a valid tool for assessment of the home environment to predict one-year changes in BMI but further study is indicated.
2.6 Tables and Figures

Table 2.1. Prevalence of obesity among children and adolescents ages 2-19 years: United States

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Adapted from Ogden, et al., 2012

Table 2.2. Aspects of parenting styles

<table>
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<tr>
<td>Low Responsiveness</td>
<td>Authoritarian</td>
</tr>
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<td>Permissive</td>
<td>Neglectful/Uninvolved</td>
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Table 2.3. Obesity prevalence by racial/ethnic group

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<th>Non-Hispanic Black</th>
<th>Hispanic</th>
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</thead>
<tbody>
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<td>2-19 years old</td>
<td>14.1</td>
<td>20.2</td>
<td>12.4</td>
</tr>
<tr>
<td>2-5 years old</td>
<td>3.5</td>
<td>11.3</td>
<td>16.7</td>
</tr>
<tr>
<td>6-11 years old</td>
<td>13.1</td>
<td>23.8</td>
<td>26.1</td>
</tr>
<tr>
<td>12-19 years old</td>
<td>19.6</td>
<td>22.1</td>
<td>12.6</td>
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Adapted from Ogden et al., 2014
Figure 2.1. Ecological model of predictors of child health

Figure 2.2. Birch and Fisher’s theoretical model of the family environment and daughter’s weight status
Figure 2.3. Flowchart of evidence analysis for development of the FNPA
2.7 References


He, Q., Ding, Z. Y., Fong, D. Y.-T., & Karlberg, Jo. (2000). Blood pressure is associated with body mass index in both normal and obese children. *Hypertension*, 36(2), 165–170. doi:10.1161/01.HYP.36.2.165


Reich, a, Müller, G., Gelbrich, G., Deutscher, K., Gödicke, R., & Kiess, W. (2003). Obesity and blood pressure—results from the examination of 2365 schoolchildren in Germany. *International Journal of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity, 27*(12), 1459–64. doi:10.1038/sj.ijo.0802462


CHAPTER 3. AN UPDATE TO THE FAMILY NUTRITION AND PHYSICAL ACTIVITY (FNPA) SCREENING TOOL

A paper for submission to *The International Journal of Behavioral Nutrition and Physical Activity*

Karissa Peyer, Greg Welk, and Pantelemion Ekkekakis

3.1 Abstract

Background: The Family Nutrition and Physical Activity (FNPA) screening tool was developed to identify obesogenic home environments to predict development of childhood obesity; however, the tool has undergone many revisions since its original validation and there is a need for refinement and evaluation of this updated tool.

Methods: Cognitive interviews \((n = 20)\) were conducted to gather qualitative feedback regarding item wording, response scales and inclusion of ‘Recommended Practice’ statements. Additionally, 155 parents were recruited to complete two online administrations of the FNPA to compare objective and subjective versions of the response scale. Inter-item and test-retest reliability were used to examine the psychometric properties of the two scales and t-tests examined differences between means. Results: Changes were made to word items and the Recommended Practices were removed following interviews. No differences were seen between means of the two versions of the response scale, but the subjective version displayed higher reliability.

Conclusions: The updated FNPA using the subjective response scale displays acceptable reliability and interpretability by parents and should be used in future studies examining home obesogenic environments that may predispose children to become overweight or obese.
3.2 Introduction

Dramatic increases in the prevalence of childhood overweight and obesity have been seen in recent decades in the United States and throughout the world (Fryar, Carroll, & Odgen, 2012; Wang, Monteiro, & Popkin, 2002). In the United States, obesity prevalence has anywhere from doubled to more than tripled, depending on the age group, from 1976 to 2010, although recent data suggests that this trend may be leveling off (Ogden, Carroll, Kit, & Flegal, 2014). A number of factors have been investigated for their role in the childhood obesity epidemic including physical activity levels, sedentary behaviors, screen time, nutrition, and sleep hygiene. In 2001, the American Dietetic Association (now the Academy of Nutrition and Dietetics) Foundation issued a call for a screening tool to identify risk factors for obesity within the home and family environment (Myers & Johnson, 2001). This call for action led to an extensive evidence analysis (andeal.org) and the creation of the Family Nutrition and Physical Activity Screening Tool (FNPA) (Ihmels, Welk, Eisenmann, & Nusser, 2009).

Traditional approaches to childhood overweight and obesity involve screening and tracking of body mass index (BMI) throughout childhood and adolescence with intervention and treatment for youth being justified if a child exceeds specific age- and gender-referenced BMI percentiles. A disadvantage of this approach is that intervention is typically only called for after a child is already overweight. The FNPA provides clinicians and dieticians with a primary prevention tool aimed at identifying home environments and practices that may predispose youth to become overweight. The advantage of this prevention approach is that counseling and intervention can help to
correct habits before weight issues become problematic and before lifestyles become entrenched.

The original FNPA contained twenty-one items reflecting ten constructs or topic areas that were identified as having an association with overweight and obesity (Ihmels, Welk, Eisenmann, & Nusser, 2009; Ihmels et al., 2007). Scores for items within constructs were summed to create a construct score and all items were summed to create a total score. Initial evaluation of the FNPA in a first grade sample showed correlations among constructs but the total FNPA score had a higher correlation with child BMI percentile (BMI%) than any individual construct. Differences in FNPA scores were evident by family income level providing a logical explanation for the higher prevalence of obesity in youth from low-income families. Children in the lowest tertile of family FNPA scores (least favorable) also had significantly higher odds for overweight and obesity than children in the highest tertile of FNPA score.

The predictive utility of the FNPA was demonstrated in a one-year follow-up with the original validation cohort. While much of the 2nd grade BMI% could be explained by the 1st grade BMI%, the FNPA score in 1st grade did explain unique variance after accounting for baseline BMI%, parent BMI, and other demographic variables. Additional studies examining the FNPA have shown significant correlations with adiposity the cardiovascular disease risk in 10-year old children (Yee, Eisenmann, Carlson, & Pfeiffer, 2011). Lower FNPA scores have also been shown to increase the odds of overfatness and Acanthosis Nigricans in 6- to 13-year old low-income children (Yee et al., 2015). Additionally, the FNPA has been shown to have utility as a counseling tool to enable
health care providers to quickly identify risk areas to be discussed during well-child visits (Christison et al., 2014).

The FNPA has proven to be a useful tool for understanding home environments and parenting practices that may predispose youth to become overweight. However, formative evaluation of recent applications suggest that changes may be warranted in some items as well as in the nature of the response scales. For example, changes in technology necessitate a broader conception of screen time to include other modes than just television and video games (e.g. tablets, gaming consoles etc…). Feedback from previous and current users of the FNPA also suggest that some parents struggle to classify their family behaviors using the current four-point subjective scale used for the FNPA items (Never/Almost Never, Sometimes, Often, Almost Always). Differentiation between categories may be difficult and interpretation may vary from family to family. For example, a child eating breakfast four days per week may be classified as “Sometimes” by one parent but as “Often” by another. The use of more objective response categories (e.g. 3 days a week, 4 days a week) may address this but direct evaluation of different formats is needed to determine the impact on parent responses.

Formative evaluation also suggested that parents may benefit from the provision of additional background information to ensure that they understand the terminology and relevance of the individual items. In clinical applications, a series of “Recommended Practices,” are typically provided to parents as an educational tool after they complete the FNPA assessment; however, the provision of information before individuals complete the FNPA items may help put questions into an appropriate context. The disadvantage, and potential risk, is that this information may also artificially inflate FNPA scores if
parents react by providing more socially desirable answers. The provision of information thus also needs to be directly evaluated.

Therefore, the aim of this study was to systematically evaluate the utility of different response scales and formats of the FNPA items. Specifically, the study compared response scales (Subjective and Objective) with and without the addition of Recommended Practices before the question items. The study included both qualitative and quantitative components. The qualitative component utilized cognitive testing to evaluate parent perceptions and interpretations of the FNPA constructs when administered with different scales and with or without the Recommended Practices. This phase provided valuable insights about parent reactions to the items and help to further refine the items. The quantitative evaluation compared scores and reliability of the Subjective and Objective versions of the FNPA to determine which response scale is most reliable and to examine how parents interpret the subjective response options.

3.3 Methods

3.3.1 Revision of FNPA Items

Members of the Iowa State University Survey and Behavioral Research Services (SBRS) staff met with the project researchers (KP and GW) to discuss wording of FNPA items and cognitive interviewing processes. Wording of multiple FNPA items were revised prior to interviews based on existing feedback from other users of the tool. Examples of changes included addition of examples of sugar-sweetened beverages (“regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade”) and screen time modalities (“tv, computer,
games system, or any mobile device with visual screen”) to ensure that parents accurately characterized youth behaviors. Items assessing restriction of chips, cookies, and candy consumption and amount of screen time were also re-worded from asking how often parents “limit” foods or screen time to how often they “monitor” them. This distinction is important to distinguish between pro-active (and generally desirable) monitoring behaviors and potentially negative restriction practices.

The SBRS and project researchers also worked together to develop an objective response scale for items that lent themselves to objective classification (items 1-8, and item 20). This led to the creation of two distinct response formats – one purely subjective and one including a mix of subjective and objective items. Consideration was also given to the provision of contextual cues before individual questions. The Recommended Practice statements that have previously been provided after completion of the FNPA were also reworded for brevity and consistency so that all Recommended Practices referenced scientific findings without overtly suggesting the preferred response to the FNPA item it described. Versions of the FNPA were then created with and without inclusion of the Recommended Practice statements prior to individual questions. The twenty FNPA questions, along with their accompanying Subjective and Objective response options and corresponding Recommended Practices are shown in Table 3.1. Both full versions of the FNPA are included in Appendix F.

3.3.2 Phase I - Cognitive Testing

The goal of Phase I was to evaluate parent reactions and understanding of the FNPA items when presented in different ways. A sample of 20 parents from the community surrounding a Midwestern university was recruited via word of mouth by
staff at Iowa State University SBRS in the summer of 2013. Participants’ age ranged from 30 to 65+ years and participants were 80% female.

Participants were then randomly assigned to one of the four versions of the FNPA. They were instructed to complete the FNPA start-to-finish without input from or discussion with the interviewer (to simulate how it would be administered at home or in a physician’s office). Following completion of the FNPA, the interviewer then led a structured discussion of each item with the parent. Each item was assessed for clarity and ease of the response options. Specific questions included how parents interpreted the terms “fast food” and “ready-to-eat foods,” and whether changing phrasing from “how often does your family…” to “how often does your child… with at least one other family member…” would have changed their responses. If parents initially received a version with the Recommended Practices, they were asked whether these recommendations influenced their responses. If they initially received a version without the Recommended Practices, they were given a version with the recommendations following the completion of discussion of their original FNPA version and asked whether they believed that being given these recommendations would influence their responses.

3.3.3 Phase II – Quantitative Evaluation

The goal of Phase II was to examine the reliability of the two response scales (Subjective and Objective) through a test-retest design to determine whether parents are able to provide more consistent responses with one of the scales, versus the other. A second goal was to determine how parents interpret the subjective response options by directly comparing intra-individual responses on the two versions.
In order to quantitatively compare the two versions of the FNPA response scales, a sample of parents (n = 155) was recruited through emails sent by school principals to parents of students in pre-Kindergarten through 3rd grade. Participants were randomly assigned into one of four groups and provided with a web link to an electronic version of the FNPA tool. Groups 1 and 2 received repeated administration of either the Subjective or Objective versions of the FNPA. Groups 3 and 4 received both the Subjective and the Objective versions, in a counter-balanced design (See Table 3.2 for assignment design). If participants had more than one child within the target age range, they were asked to complete the screening tool with one specific child in mind. Participants also provided additional demographic information including child age and parent gender, age, weight status, ethnicity, education and income. One month after initial completion of the FNPA, participants were asked to complete the tool once more, based on their group. Approval for this study was obtained from the Institutional Review Board of Iowa State University (Appendix A) prior to study initiation and participants were informed of the procedures and purpose of the study and completed informed consent documents prior to beginning the surveys.

3.4 Data Analyses

Descriptive analyses were performed and chi-square tests were used to check for any differences between parents completing each version of the FNPA. Analyses focused on evaluation of the reliability of each version and a comparison of the scores from the various versions. Reliability was evaluated by calculating correlation coefficients between the first and second administrations of the FNPA. Differences in average score
between the Subjective and Objective versions were examined with t-tests. Frequencies were also used to examine agreement between the Objective and Subjective scales.

3.5 Results

3.5.1 Phase I

Data from Phase I cognitive interviews included FNPA scores and researchers’ notes from the interview. The comments and observations from the interviews were discussed with the SBRS research team to confirm commonly heard themes. Parents generally stated that the response scale they were provided worked well for the FNPA items. Parents commonly stated that provision of the Recommended Practices did not influence their own responses but that they believed they might influence others.

- “The paragraph was very leading, telling me how to answer.”
- “You’ll get more honest responses without the paragraphs. With them the results are going to be skewed more positively. Paragraphs given after the fact would be good, educational.”
- “With the paragraph I would have felt more apt to answer less truthfully. Would not mind if the Recommended Practices were given...after completing the survey.”
- “I feel like I am being lectured.”

One parent suggested removing the Recommended Practices even before being asked for their perspective on the statements. There seemed to be a strong consensus that providing the Recommended Practices may cause parents to alter their responses. The
cognitive testing led to some minor changes in the wording of specific items. The specific changes made to the FNPA items following the cognitive interviews are listed below.

- Item 1: Addition of “either at home or at school,” to breakfast question
- Items 2 and 16: Changed from “how often does your family…” to “how often does your child….with at least one other family member?”
- Item 3: Focus changed from family to child
- Examples provided for items 7, 8 and 11.
- Items 9 and 12: Changed from “limits” to “monitor.”
- Item 13: Changed from TV in bedroom to screen time in bedroom.

3.5.2 Phase II

A total of 187 parents signed up for Phase II of the study by completing an online form to provide their email address to the research team and so were sent links to complete the FNPA online. Of these, 155 participants submitted at least one survey and 106 participants submitted surveys at both time points, for a total of 130 Subjective and 128 Objective surveys submitted.

The majority of survey respondents (89.7%) were mothers or female guardians and most respondents were between 30 and 50 years old (91.6%). Over one-third (36.6%) of the sample was parents of children in Pre-K or Kindergarten, while 29% were parents of 1st grade students, 15.3% were parents of 2nd grade students and 19.1% were parents of 3rd grade students. The sample was predominately White/Caucasian (92.4%) with less than 3% each identifying as Hispanic/Latino or Asian and less than 2% as Black/African American. Family income was reported as follows: 6.9% of families reported annual
income of $40,000 or less, 31.5% earned $40,000-$70,000, 25.9% earned $70,000-$100,000, and 34.3% earned at least $100,000 per year. The sample was well-educated with 93.1% having a post-secondary degree (32.4% had Masters/Professional/Doctorate degree). No differences were found for child grade, parent gender, race, income, or education level by group assignment.

Test-retest reliability was performed with surveys submitted by participants who had completed the same survey twice (Objective n = 28, Subjective n = 30). These analyses showed better retest properties for the Subjective version of the FNPA (r = 0.90) compared to the Objective version of the survey (r = 0.76). Inter-item reliability (Cronbach’s Alpha) was performed on all first surveys (Objective for Groups 1 and 3, n = 71; Subjective for Groups 2 and 4, n = 68). These results again showed stronger psychometric properties for the Subjective (α = 0.77) compared to the Objective (α = 0.67) scale.

When comparing means of the two versions of the survey, there was not a significant difference (p = 0.23). Mean score for all participants who completed the Objective version for their first survey (n = 71) was 64.20 ± 5.5; mean score for all participants who completed the Subjective version for their first survey (n = 68) was 64.82 ± 6.3. Results were similar when evaluating means scores for all surveys across both time points (Objective n = 132, mean = 64.71; Subjective n = 130, mean = 65.42).

There was generally good agreement between the Subjective and Objective categories by parents who completed both versions of the survey. When participants selected the “6-7 days per week” category, they were most likely to also select the
“Always/Almost Always” category (78.8%). When participants selected the “3-5 days/week” category, they were most likely to also select the “Often” category (61.5%). A noticeable deviation from this was the item asking about the amount of sleep children obtain. Of the 30 parents who reported that their child “Always or Almost Always” gets enough sleep, 16 of these selected the “10-12 hours” category and 14 selected the “8-10 hours” category.

3.6 Discussion

The results of the study provided valuable insights about the utility of different survey formats and features. The cognitive interviews performed as the first component of this study provided insights into the thought process of parents as they complete the FNPA. This feedback helped to refine the wording of a number of items. Parents expressed a need for items examining family interactions (family meals and family physical activity) to not be limited to those performed with the entire family, as a child may be active with siblings or one parent but not necessarily the entire family. Similarly, if one sibling is not home for a family dinner, an item asking about “family meals” would not accurately capture the value of this meal. Similar broadening of constructs was done with the breakfast item to expressly state the breakfast should be counted whether it was consumed at home or through a school-based program.

Overwhelmingly, participants felt that the inclusion of the Recommended Practices could alter responses or perceptions of parents, while there was no consensus from cognitive interviews about the relative advantages of the Subjective and Objective response formats. Participants found the Recommended Practices to be leading or even “lecturing.” Many participants stated that they thought the Recommended Practices
should be provided after the survey as an educational tool, but that providing them before the survey questions would lead to parents answering the items less honestly. Due to this feedback, the quantitative evaluation of the Objective and Subjective versions of the survey did not include the Recommended Practices.

Quantitative evaluations showed similar mean scores for the Subjective and Objective versions of the survey but stronger psychometric properties of the Subjective version. Both test-retest reliability and item-item reliability were stronger for the fully Subjective version, suggesting that parents may be able to provide more consistent answers when using this scale. While this was contrary to feedback and concerns expressed by current practitioners and researchers using the tool (personal correspondence), it may be that parents feel that variation in weekly schedules or routines do not allow for a “days/week” option to accurately capture the overall habits of the family and the child and that these categories may be too sensitive to small variations in pattern rather than capturing a family’s overall lifestyle. However, it must also be considered that the Subjective categories allow parents to be more general in their estimations of family and child behaviors and may therefore result in less valid estimations of lifestyle patterns. The validity of the FNPA compared to objective measurement of the included behaviors was not evaluated in this study and would, in fact, be very difficult to assess as the tool captures so many different aspects of the obesogenic environment.

Current analyses suggest that the updates to the FNPA may have led to some improvement of the internal consistency of the instrument. The Subjective version examined in the current study had an alpha reliability of $\alpha = 0.76$. In the initial validation,
two items were excluded after apparent misinterpretation by parents and the resulting 19 items had slightly lower reliability ($\alpha = 0.72$) than the current version of the tool.

To the authors’ knowledge, this is the first study to directly compare two response scale options pertaining to the same questionnaire items. Thus, the findings may generalize to other survey applications attempting to characterize behaviors. The need for the present analyses was driven primarily by user feedback stating that parents were unsure of how to interpret Subjective response categories such as “often” or “sometimes” when filling out the survey. The direct comparison through both qualitative (cognitive interviews) and quantitative evaluations of the formats is a specific strength of this study.

The current study shows that parents are generally consistent in their interpretation of Subjective response scale items and that these interpretations generally correspond to the alternative days/week categories proposed in the alternative version of the FNPA used in this study. While this may suggest that practitioners could use whichever version of the screening tool that they and their patients are most comfortable with, use of the Objective (days/week) options may be more sensitive to small seasonal differences or inter-rater differences. Future work examining the FNPA should test inter-rater reliability between parents of the same child to determine whether co-parents interpret the home environment similarly.

The current study is limited by the homogeneous nature of the sample used and small sample sizes. Parents were predominately White/Caucasian and had high education and income level. Previous work has shown the utility of the FNPA in low-socioeconomic samples (Yee et al., 2015), but additional work is needed in diverse populations. The current sample was similar to the age range used in development and
initial validation of the FNPA (Ihmels, Welk, Eisenmann, Nusser, & Myers, 2009; Ihmels, Welk, Eisenmann, & Nusser, 2009), but future research should also examine the utility of the FNPA in older children. The small samples, especially when examining test-retest reliability may have resulted in low stability of the correlation estimates. These relationships should be evaluated further in larger samples that will be less likely to be influenced by individual data points.

The Family Nutrition and Physical Activity screening tool has been shown to predict changes in child weight status (Ihmels, Welk, Eisenmann, Nusser, et al., 2009) and to correspond with risk factors including high body fat, cardiovascular disease risk and Acanthosis Nigricans (Yee et al., 2015, 2011). The tool has undergone subtle changes over time since the initial validation and the current study examined several modifications to determine the version of the tool most interpretable by parent users and with the best psychometric properties. This work provides researchers and clinical users of the FNPA with the first tested and reliable update to the tool since its original creation. Future research of the FNPA should utilize the Subjective version developed and tested in this study to analyze the home environment and identify children at risk for future weight gain, overweight, and obesity.
3.7 Tables

Table 3.1: Items, responses and Recommended Practices for the FNPA

<table>
<thead>
<tr>
<th>Objective Item</th>
<th>Subjective Item</th>
<th>Objective Responses</th>
<th>Subjective Responses</th>
<th>Recommended Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a typical week, how many days does your child eat breakfast, either at home or at school?</td>
<td>How often does your child eat breakfast, either at home or at school?</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td>Children who regularly skip breakfast show an increased risk of becoming overweight, particularly among older children and adolescents. Eating meals together as a family helps to encourage positive family interactions related to eating.</td>
</tr>
<tr>
<td>In a typical week, how many days does your child eat at least one meal with another family member?</td>
<td>How often does your child eat at least one meal a day with at least one other family member?</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td>Regularly eating food away from home, particularly at fast food establishments, has been associated with increased risk for overweight. Reducing meals out can promote healthier eating. Also, watching television while eating meals can cause children to eat too much or to eat less healthy foods.</td>
</tr>
<tr>
<td>In a typical week, how many days does your child eat while watching TV? [Includes meals or snacks]</td>
<td>How often does your child eat while watching TV? [Includes meals or snacks]</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>In a typical week, how many days does your family eat &quot;fast food?&quot;</td>
<td>How often does your family eat &quot;fast food?&quot;</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>In a typical week, how many days does your family use packages &quot;ready-to-eat&quot; foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</td>
<td>How often does your family use packaged &quot;ready-to-eat&quot; foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td>Prepackaged foods generally contain more fat and salt than freshly prepared meals, and dietary fat intake is associated with higher overweight levels in youth. Eating more fruits and vegetables reduces a child's risk for being overweight.</td>
</tr>
<tr>
<td>In a typical week, how many days does your child eat fruits and vegetables at meals or snacks? [Not including juice]</td>
<td>How often does your child eat fruits and vegetables at meals or snacks? [Not including juice]</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Frequency Options</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In a typical week, how many days does your child drink soda pop or sweetened beverages? [Includes regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, fruit or vegetable juice, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade, etc.]</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td><strong>Never or Almost Never/Sometimes/Often/Almost Always</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often does your child drink low-fat milk for meals or snacks? [Includes 1% or skim dairy, flavored, soy, almond, etc.]</td>
<td>0 days/1 or 2 days/3 to 5 days/6 or 7 days</td>
<td><strong>Never or Almost Never/Sometimes/Often/Almost Always</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often does your family monitor the amount of candy, chips, and cookies your child eats?</td>
<td><strong>Never or Almost Never/Sometimes/Often/Almost Always</strong></td>
<td><strong>Forbidding items such as snack food and candy can actually increase a child's desire for those foods. Using these kinds of foods as rewards can cause children to value them over other healthier options.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often does your family use candy, ice cream or other foods as a reward for good behavior?</td>
<td><strong>Never or Almost Never/Sometimes/Often/Always or Almost Always</strong></td>
<td><strong>Frequent intake of sugar-sweetened beverages is related to an increased risk of children becoming overweight. Increased intake of calcium/dairy (milk) may decrease risk of overweight.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1 Continued

<table>
<thead>
<tr>
<th>Question</th>
<th>Never or Almost</th>
<th>More/Less or Almost Always</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often does your child have less than 2 hours of &quot;screen time&quot; in a day? [Includes TV, computer, game system, or any mobile device with visual screens]</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td>Excessive television viewing and video game use is associated with increased overweight in youth. Current recommendations are that children should have 2 hours or less of screen time (television, video games, and computer time) per day.</td>
</tr>
<tr>
<td>How often does your family monitor the amount of &quot;screen time&quot; your child has?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td>Removing televisions and other screen devices from bedrooms helps to reduce the likelihood of excess use. Providing opportunities to be physically active may reduce overweight in youth.</td>
</tr>
<tr>
<td>How often does your child engage in screen time in his/her bedroom?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>How often does your family provide opportunities for physical activity?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td>Children sometimes need to be encouraged to be physically active. By being active as a family you can help establish healthy lifestyle practices that promote and reinforce physical activity as a family value.</td>
</tr>
<tr>
<td>How often does your family encourage your child to be physically active?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>How often does your child do physical activities with at least one other family member?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td>A child's participation in sports and other regular physical activity is associated with a reduced risk of becoming overweight.</td>
</tr>
<tr>
<td>How often does your child do something physically active when he/she has free time?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
<tr>
<td>How often does your child participate in organized sports or physical activities with a coach or leader?</td>
<td>Never or Almost</td>
<td>Never/Sometimes/Often/Always or Almost Always</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1 Continued

<table>
<thead>
<tr>
<th>How often does your child follow a regular routine for your child's bedtime?</th>
<th>Never or Almost Always/Sometimes/Often/Always or Almost Always</th>
<th>Most children respond best to a daily routine or schedule for bedtime. Research suggests that lack of sleep and irregular routines may increase a child's risk for becoming overweight.</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many hours does your child usually sleep in a 24-hour period?</td>
<td>How often does your child get enough sleep at night?</td>
<td>Less than 8 hours/8 to 10 hours/10 to 12 hours/More than 12 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never or Almost Never/Sometimes/Often/Always or Almost Always</td>
</tr>
</tbody>
</table>

Table 3.2. Survey allocations for Phase II

<table>
<thead>
<tr>
<th>Group</th>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>Objective</td>
</tr>
<tr>
<td>2</td>
<td>Subjective</td>
<td>Subjective</td>
</tr>
<tr>
<td>3</td>
<td>Objective</td>
<td>Subjective</td>
</tr>
<tr>
<td>4</td>
<td>Subjective</td>
<td>Objective</td>
</tr>
</tbody>
</table>
3.8 References


CHAPTER 4. CONSTRUCT VALIDITY OF AN OBESITY RISK SCREENING TOOL IN TWO AGE GROUPS

For submission to Childhood Obesity

Karissa L. Peyer and Greg J. Welk

4.1 Abstract

Background: Home environment and parenting practices are known to influence children’s health but the nature and impact varies as children move from childhood to adolescence. The Family Nutrition and Physical Activity (FNPA) screening tool has been widely used to evaluate home obesogenic environments but studies to date have not directly compared the utility of the tool in different age groups. The purpose of this study was to examine the influence of home environment and sociodemographic factors on obesity risk in 1st and 10th grade samples. Methods: Parents of 1st grade (n = 250) and 10th grade (n = 99) students completed the FNPA and results were linked to BMI data collected through the FITNESSGRAM battery. Patterns in FNPA scores were examined by gender, income, race, and school-level socioeconomic status (SES). Correlations examined associations among FNPA scores and both BMI percentile (BMI%) and an alternative BMI indicator that captures BMI values relative to the 50th percentile (BMI50). Logistic and linear regression analyses evaluated the construct validity of the FNPA in both age groups. Results: Mean FNPA score differed by age group and by school SES level in both age groups and by racial/ethnic group in the 1st grade sample only. Weak correlations were found between FNPA score and BMI indicators, although these relationships were not significant in 10th graders. Parent weight was a significant predictor of BMI50 in both age groups. School SES had a significant influence on both
BMI% and BMI50 in 10th graders but not 1st graders. Conclusions: The FNPA score has stronger utility in younger children while school SES is a stronger predictor of weight status in adolescents. Obesity prevention and future research should consider differences in the influence of home and social environments at different ages.

4.2 Introduction

The high prevalence of childhood obesity rates remains a top public health priority with approximately 17% of children aged 2-19 years now classified as obese (Ogden, Carroll, Kit, & Flegal, 2014). Trends have been largely stable since 2003-2004; however, there have been documented differences in the patterns of change between children and adolescents. While children age 6-11 have shown a decrease in obesity rates from 18.8% in 2003-2004 to 17.7% in 2011-2012, obesity rates have shown a slight increase in children age 12-19 from 17.4% in 2003-2004 to 20.5% in 2011-2012 (Ogden et al., 2014). Evidence suggests that there are also disparities in patterns of obesity across ethnic groups with higher prevalence of obesity among Black and Latino children than in White children (Trust for American’s Health & Robert Wood Johnson Foundation, 2014).

These discordant patterns suggest that different factors may be playing a role in the prevalence of overweight and obesity in these different age groups. In order to reverse the overall trend in obesity rates, these (potentially different) factors need to be identified and targeted. Parenting behaviors and the home environment are known to play a critical role in child health (Arredondo et al., 2006; Blissett & Haycraft, 2008; Clark, Goyder, Bissell, Blank, & Peters, 2007; Krahnstoever Davison & Birch, 2002; Kirsten Krahnstoever Davison, Cutting, & Birch, 2003; Faith et al., 2004; Fisher & Birch, 2002;
However, the overall influence of parents (and the specific influence on eating, screen time, and physical activity) are known to decrease as children move into adolescence (Buhrmester & Furman, 1987; MacDonald & Parke, 1986; Story, Neumark-Sztainer, & French, 2002). Davison and colleagues (Krahnstoever Davison, Jurkowski, & Lawson, 2012) have suggested a specific model of the Ecological Systems Theory to illustrate how child physical activity, dietary intake and sedentary behavior are influenced by parent behaviors and societal characteristics. Specific parenting practices that may influence child weight status include frequency of fast-food and family meals, creating opportunities for active play, and enforcing rules for screen time. However, the age of the child is also an influential factor in this model.

Current approaches for childhood overweight and obesity largely focus on identifying children once they reach the overweight or obese categories and then providing treatment to try to reverse weight gain trends (Ho et al., 2012; Kirschenbaum & Gierut, 2013) but this may be too late for effective intervention. The tenets of health promotion emphasize the importance of primary prevention so it would clearly be more effective to focus on early identification of risk factors and unhealthy habits and provide counseling and guidance before weight has reached a risky level. The Family Nutrition and Physical Activity (FNPA) screening tool was developed to identify families and children with home environments that may increase a child’s risk for overweight and obesity (Ihmels, Welk, Eisenmann, & Nusser, 2009). The FNPA survey contains twenty items that assess ten constructs - factors that have been shown to increase risk for obesity,
providing practitioners with an opportunity for early intervention (Ihmels et al., 2007). These constructs include Family Meals, Family Eating Practices, Food Choices, Beverage Choices, Restriction/Reward, Screen Time, Healthy Environment, Family Activity, Child Activity, and Sleep Routine.

Previous research has supported both construct validity (Ihmels, Welk, Eisenmann, & Nusser, 2009) and predictive validity (Ihmels, Welk, Eisenmann, Nusser, & Myers, 2009) of the FNPA in young children; however, it has not been examined in older youth. It is valuable to examine the relationship between the FNPA and weight status among different age groups, as parenting practices and environments may have differential effects on youth behaviors and weight status as children move from elementary school to middle school and high school. Further, small (but potentially important) changes have been made to the wording of some FNPA items and response options since the original validation work was conducted. Re-examination of the relationship between FNPA score and weight status in a new cohort of 1st graders will allow for determination of any differences between the original tool and the revised version. Comparisons between associations in 1st graders and a sample of older children from the same district will make it possible to determine if FNPA has differential utility by age. This study provides new insights about the utility of the FNPA tool by evaluating the relative strengths of associations between FNPA and BMI in two separate ages: 1st grade (~7 years old) and 10th grade (~15 years old).
4.3 Methods

4.3.1 Design and Sample

The study was conducted through an ongoing participatory research agreement with a large Midwestern school district. As part of the process, physical education teachers provide de-identified data on health related fitness based on the established FITNESSGRAM testing protocol. The battery includes reports of body composition (based on BMI) as well as other health related fitness data. The present study examines only height and weight since focus is on the changes in BMI. Height was measured using a Charder Medical HM200P stadiometer (Taichung City, Taiwan) and weight was measured using a digital scale (Omron SC100, Kyoto, Japan).

Parents of students in 1st grade and 10th grade were contacted to complete the FNPA and demographic surveys and to allow their child’s FITNESSGRAM (BMI) data to be merged via student ID, which was provided with the surveys. In the first grade sample, parents were recruited via email and hardcopy letter sent to all first grade parents. These letters provided a link to the online Informed Consent, FNPA survey and demographic surveys (Appendix G). Parents in the tenth grade sample were recruited via mailed survey packets to parents from the original FNPA validation cohort that were still enrolled in the school district. Demographics included parent age, gender, race, and education level; household income; and height and weight for both mother and father.

School-level participation (% of students) in the national free- and reduced price lunch program was obtained from publicly available sources and used as a proxy for school-level socioeconomic status.
4.3.2. Description of the FNPA Tool

The original FNPA screening tool contained 21 items reflecting ten constructs or topic areas that have been identified as risk factors for overweight/obesity. The constructs include Family Meals, Family Eating Practices, Food Choices, Beverage Choices, Restriction/Reward, Screen Time, Healthy Environment, Family Activity, Child Activity, and Sleep Routine. Over time, changes have been made to standardize the response scale and number of items per construct. The updated version of the FNPA assesses the frequency with which each behavior in question is performed using a four-point Likert scale with options “Never/Almost Never,” “Sometimes,” “Often,” and “Very Often/Always.” For the majority of the screening items, Almost Always/Always is the preferred response and is scored as a 4 while the lowest scoring response (1) is Never/Almost Never. Six items are reverse scored with Never/Almost Never being the preferred response. The total FNPA score is calculated by summing scores. In addition to the total FNPA score, scores for each of the ten constructs are created by summing the scores for the two items within that construct.

4.3.3 Data Processing

BMI percentile (BMI%), based on age- and gender-specific references, were calculated from gender, height, weight, and age at test date using standard CDC SAS codes. While these are commonly used for descriptive purposes there are known limitations in using BMI percentiles (Cole, Faith, Pietrobelli, & Heo, 2005; Paluch, Epstein, & Reommich, 2007). This is due to the flattening of the BMI% curve at higher weight status and the differential widths between centiles. For example, a ten-year old boy who is 4’5” and weighs 70 pounds has a BMI% of 65% while a boy weighing 90
pounds has a BMI% of 95%, (a difference of 30 percentile points). In contrast, boys of the same age and height weighing 110 pounds or 130 pounds would have BMI% of 98% and 99% respectively (a difference of only 1 percentile point). This problem has been well described in the literature (Cole et al., 2005; Paluch et al., 2007) and an alternative index (Percent Over BMI, called BMI50 here) has been proposed to more effectively capture the relative distance of and observed BMI from a given standard (Paluch et al., 2007). The present study uses an index referred to as BMI50 to capture the relative difference between an individual’s measured BMI and the BMI value for the 50th percentile for age and sex. The calculation is shown below:

\[ \text{BMI50} = \frac{\text{child BMI} - \text{BMI for 50th percentile}}{\text{BMII for 50th percentile}} \times 100 \]

In both age groups, parent BMIs were used to calculate a Parent BMI Risk Score. Underweight and normal-weight parents received a score of zero, overweight parents a score of 1 and obese parents a score of two. These scores were then summed to create a total risk score for each child.

### 4.4 Data Analyses

The focus of the analyses was on examining cross sectional associations between the FNPA and BMI in two different age groups. Descriptive analyses were provided to summarize the demographic characteristics of the 1st and 10th grade samples. The prevalence of overweight (≥85th BMI percentile) and obesity (≥ 95th BMI percentile) were calculated for both age groups to determine BMI characteristics by gender, racial/ethnic group (White vs non-White), and income categories. Descriptive analyses were computed to examine the patterns in the FNPA data and associations among the
various FNPA indicators. One-way ANOVAs were used to examine differences in total FNPA score by gender, race, school SES level, and income categories. Scores for the ten individual FNPA constructs by these demographic categories are also reported but were not statistically evaluated due to concern for excessive comparisons and alpha inflation. Associations between FNPA constructs and the two different BMI indicators were evaluated using correlations analyses. Logistic regressions were conducted to evaluate the construct validity of the FNPA in both age groups. For these analyses, children in each grade were grouped into tertiles based on total FNPA score to evaluate whether significant differences in odds of overweight/obesity ($\text{BMI}\% \geq 85\%$) exist between children in the highest and lowest tertiles of FNPA score.

Linear regression analyses were used to evaluate the relationship between home environment and current weight status in more detail. Separate models were run for both age groups to enable direct comparisons. The models controlled for the possible differences in weight status caused by the socioeconomic status of the schools, child gender, race, parent BMI and family income to allow the independent influence of FNPA score to be determined.

All procedures were approved by the Institutional Review board at Iowa State University (Appendix B) and by the participating school district.

4.5 Results

4.5.1 Comparisons of the Sample Demographics

In 1st graders, survey and anthropometric data were available for 250 students with similar samples for males ($n = 128$) and females ($n = 122$). Descriptive statistics for
body mass, height, BMI and BMI percentile are shown in Table 4.1. The majority of the sample (81.45%) was White/Caucasian with smaller samples of Black/African American (7.26%), Hispanic/Latino (4.03), and Asian (4.44%) (2.83% were categorized as “Other”). Due to small samples of minority racial/ethnic groups, all participants identifying as a group other than White/Caucasian were combined into a non-White group (18.55%) for further analyses. The majority of surveys were completed by mothers/female guardians (85.48%). Nearly half of parents (46.19%) reported having at least a bachelor’s degree with 9.64% having a high school education or less. Income was reported as follows: 5.62% of families earned less than $20,000 per year, 18.07% earned between $20,000 and $40,000, 27.71% earned between $40,000 and $70,000, 21.69% earned between $70,000 and $100,000, and 26.91% earned $100,000 per year or more.

In the 10th grade sample, survey and anthropometric data were available for 99 students: males (n = 53) and females (n = 46). Descriptive statistics for body mass, height, BMI and BMI percentile are shown in Table 1. The majority of the sample (78.57%) was White/Caucasian with smaller samples of Black/African American (6.12%), Hispanic/Latino (8.16%), and Asian (6.12%) (1.02% were categorized as “Other”). As was done with the 1st grade sample, all participants identified as a racial/ethnic group other than White/Caucasian were combined into a non-White group (21.43%). The majority of surveys were completed by mothers/female guardians (81.63%). Over one-third of parents (42.26%) reported having at least a bachelor’s degree with 24.75% having a high school education or less. Income was reported as follow: 8.70% of families earned less than $20,000 per year, 17.39% earned between
$20,000 and $40,000, 23.91% earned between $40,000 and $70,000, 20.65% earned between $70,000 and $100,000, and 29.35% earned $100,000 per year or more.

4.5.2 Weight Distributions

The distribution of weight categories by age group and gender are provided in Figure 4.1. In the first grade sample, 58.59% of males were normal-weight, 10.16% were underweight, 17.97% were overweight, and 13.28% were obese while 70.49% of females were categorized as normal-weight, 0.82% as underweight, 17.21% as overweight, and 11.48% as obese. Collapsing across genders, 12.40% of the students were classified as obese and 30.0% of students were classified as either overweight or obese, slightly below documented trends nationwide (18.6% obese and 31.8% overweight/obese (Ogden et al., 2014). No differences in the prevalence of overweight or obesity were seen when comparing White to non-White children (p = 0.88) or when comparing income groups (p = 0.49). Because de-identified data were available from a larger and more representative sample of students involved in the FITNESSGRAM partnership, it was possible to compare survey respondents to non-respondents. The distributions among underweight (< 5th percentile), normal weight (5th<85th percentile), overweight (85th<95th percentile) and obese (≥ 95th percentile) weight categories in this sample were not significantly different from the distribution of the total population (n = 2217) from which the sample was taken (p = 0.54). The mean BMI for mothers was 29.6 kg/m² and the mean BMI for fathers was 29.4 kg/m². Consistent with national data (Flegal, Carroll, Kit, & Ogden, 2012), 61.6% of mothers and 73.2% of fathers were either overweight or obese.
In the 10th grade sample, 60.38% of males were normal-weight, 1.89% were underweight, 20.75% were overweight, and 16.98% were obese while 45.65% of females were categorized as normal-weight, 30.43% as overweight, and 23.91% as obese. Collapsing across genders, 16.98% were classified as obese and 37.73% of students were classified as either overweight or obese, exceeding documented nationwide trends for obesity (Ogden et al., 2014). There were no significant differences in prevalence of overweight or obesity between White and non-White adolescents (p = 0.78) or between income groups (p = 0.82), and no significant differences in the proportion of the sample classified as underweight, normal weight, overweight, or obese compared to the total population (n = 1023) from which the sample was taken (p = 0.07). The mean BMI for mothers was 28.1 kg/m² and the mean BMI for fathers was 28.7 kg/m². This sample of parents was slightly leaner than national averages (Flegal et al., 2012), with 48.48% of mothers and 67.67% of fathers being either overweight or obese.

4.5.3 Descriptive Analyses of FNPA Scores

Descriptive results for raw scores on the FNPA are summarized in Tables 4.2a and 4.2b, including gender, weight, race, and school SES comparisons. Scores on the FNPA were found to not be normally distributed (left-skew) so data were cube-transformed for these analyses. In general, FNPA scores were higher for first graders (mean = 65.6) than for tenth graders (mean = 57.5). In first graders, highest scores were seen on the Meals, Restriction, Environment, and Sleep constructs, with lowest scores on the Beverages and Screen constructs. In the 1st grade sample, FNPA scores were significantly lower in the lowest tertile of school SES compared to both middle and high SES schools (p < 0.05). FNPA scores were also significantly higher (p < 0.05) for
children with family incomes between $70,000 and $100,000 per year compared to the lowest income group. This difference was not significant when comparing the lowest income group to the very highest income group (> $100,000 per year). FNPA scores were significantly higher for White/Caucasian students (mean = 66.6) than for non-White students (mean = 64.5). No differences in average FNPA score were seen between genders or between normal weight and overweight/obese students.

Some similarities were seen in 10th grade, with high scores on the Meals, Food Choices, Sleep and Restriction constructs and lowest scores on the Screen and Child PA constructs. In 10th grade students, there were significant differences in average total FNPA score between boys and girls (p = 0.02) and between students in the highest and lowest tertiles of school SES (P < 0.05), but no differences between racial/ethnic group or by family income level. For both age groups, the specific constructs that differed most between high and low income and high and low SES groups included Food Choices and Screen Time. In 1st graders, Child Physical Activity was also substantially lower in the lowest income bracket compared to families with an annual income of $70,000 - $100,000.

There were moderate and significant correlations among the various FNPA constructs showing some clustering of behaviors and environments. For example, in 1st graders, there were significant correlations among the various nutrition items and also among the various physical activity items but weaker associations between areas. The Screen Time construct was also moderately correlated with Eating (r = 0.43), Food Choices (r = 0.39), Beverages (r = 0.32), and Reward and Restriction (r = 0.34). The full set of inter-construct correlations in the 1st grade sample can be found in Table 4.3.
Patterns of correlations between constructs in the 10\textsuperscript{th} grade sample were similar to those found in the 1\textsuperscript{st} grade sample with moderate correlations among many of the various nutrition constructs and among the various physical activity constructs (Table 4.4). The Reward and Restriction construct was also moderate correlated with Eating (r = 0.34), Beverages (r = 0.32), Screen Time (r = 0.41), and Physical Activity Environment (r = 0.33).

4.5.4 Associations Among FNPA and BMI Indicators.

A key goal in the analyses was to examine and compare associations between FNPA scores and BMI distributions in both age groups. Correlations between the cube-transformed FNPA score and BMI indicators were low in both age groups but varied to some extent based on the BMI indicator used for comparison. In 1\textsuperscript{st} graders, correlations were low and not significant with BMI\% (r = -0.09, p = 0.14) but somewhat higher and statistically significant with BMI\_50 was used (r = -0.17, p = 0.01). Similar patterns were evident in 10\textsuperscript{th} graders with a low correlation with BMI\% (r = -0.07, p = 0.46), and slightly stronger association with BMI\_50 (r = -0.19, p = 0.06).

The different results for the two BMI indicators suggest that they are providing slightly different information. Correlations were high between the BMI\% and BMI\_50 indicators in both 1\textsuperscript{st} graders (r = 0.78, p < 0.001) and 10\textsuperscript{th} graders (r = 0.82, p < 0.001) but it is noteworthy that associations were much weaker when comparing child BMI\% and BMI\_50 to parent BMIs in both 1\textsuperscript{st} grade (r = 0.13-0.22, p < 0.05) and in 10\textsuperscript{th} grade (r = 0.06-0.28, p = 0.01-0.58).
To further examine associations between FNPA scores and BMI, the sample was stratified into tertiles based on FNPA scores. In 1st graders, the prevalence of obesity was significantly higher in children in the lowest tertile of FNPA score (least healthy home environment) (prevalence = 21.25%) compared to children in the highest tertile of FNPA scores (prevalence = 5.97%). The logistic regression analysis showed significantly higher odds for overweight/obesity (OR = 2.49, CI: 1.17-5.31) in children with FNPA scores in the lowest tertile compared to children in the highest tertile. Because additional factors may influence the home environment and obesity risk, additional covariates were added to the model, including school-level SES, race, and parent BMI risk score. Addition of these factors to the model rendered the influence of FNPA tertile insignificant, largely due to the parent BMI risk score. Children with two normal-weight parents (OR: 0.24, CI: 0.08-0.7885) or one overweight and one normal-weight parent (OR: 0.33, CI: 0.13-0.8584) had significantly lower odds of overweight/obesity compared to children with two obese parents.

These relationships were different in 10th graders. Contrary to associations in first grade students, an FNPA score in the lowest tertile for 10th graders did not significantly increase odds of overweight/obesity when compared to the highest tertile of FNPA scores (OR: 2.40, CI: 0.92-6.25). The addition of FRPL participation, race, and parent BMI risk score, revealed that school-level SES is a significant predictor of overweight/obesity in this age group (p = 0.03). Students attending schools in the highest tertile of participation in the FRPL program, and therefore the lowest SES schools, had dramatically higher odds of being overweight/obese compared to students attending the highest SES schools (OR = 5.06, CI: 1.54-16.59).
4.5.5 Linear Regression Analyses for BMI Measures

Linear regression analyses examined the impact of school-level socioeconomic status, gender, race, parent weight status, family income, and FNPA score (cubed) on weight status. In 1st graders, the only significant predictor of BMI% was parent BMI risk score (p = 0.004). Analyses with BMI50 showed similar results. Tables 4.5a and 4.5b contain the Estimate and Standardized Estimate for the progression of models for BMI% and BMI50.

In the 10th grade sample BMI% model, only school-level SES had a significant influence on BMI% (p = 0.03). However, in the BMI50 models, both parent BMI risk score and school-level SES influenced BMI50 in 10th grade students (p = 0.01 and 0.02, respectively). Tables 4.6a and 4.6b contain the Estimate and Standardized Estimate for the progression of models for BMI% and BMI50.

4.6 Discussion

The study examined the utility of the FNPA screening tool in two age groups to identify home environments that increase an individual’s risk for obesity. While many items have been edited since the original validation of the FNPA (Ihmels, Welk, Eisenmann, & Nusser, 2009), many of the relationships observed with the original tool were again observed with the 1st grade sample in the current study. For example, children with an FNPA score in the lowest tertile were found to have increased odds for overweight/obesity compared to children in the highest tertile both in the original study (OR 1.7, CI 1.07-2.80) and in the current evaluation (OR = 2.49, CI: 1.17-5.31). The inclusion of parent weight status rendered the FNPA tertile insignificant in both studies;
however, it is important to note that this relationship appears stronger in the current study, suggesting that changes to the FNPA since its original development may have strengthened the ability of the tool to identify risk for overweight.

The correlations between BMI50 and FNPA scores in both age groups (1st grade: $r = -0.17$; 10th grade: $r = -0.15$) were similar to the relationship found with raw BMI in the original validation of the FNPA ($r = -0.17$, $p < 0.01$). However, it is worth noting that, in the current study, these relationships were not as strong when using BMI% as the weight status variable. Because the original validation used raw BMI for most analyses, it is possible that the lack of relationship seen with BMI% is due to the shape of the weight curve. Raw BMI and BMI50 allow of more clear distinctions to be seen between children at the high end of the weight curve, where children of different raw BMI may become tightly clustered when converting to BMI percentile.

Indicators of family or parental socioeconomic status, such as income and food insecurity, have been shown to be associated with child weight status. There is also evidence of an increase in disparities in obesity rates between socioeconomic groups over recent years (Bailey-Davis, Horst, Hillemeier, & Lauter, 2012; Frederick, Snellman, & Putnam, 2014), and research has shown that high family income does not protect against the risk of obesity conferred by living in a high-deprivation neighborhood (Rossen, 2014). These findings were supported in the present study with significant influences of school SES on FNPA scores evident in both age groups and with family income showing significant influence on FNPA scores in the 1st grade sample. Scores on the Food Choices and Screen Time constructs were most likely to differ between SES and income groups, suggesting that these may be the areas of the home environment most influenced by
economic deprivation. While these factors did not translate to increased risk for overweight/obesity in the logistic regression analyses, there was a significant influence of school SES on both BMI% and BMI50 in the 10th grade sample. Rates of child obesity and overall child health are known to be inversely associated with family income (Chatterji, Lahiri, & Song, 2011; Lee, Andrew, Gebremariam, Lumeng, & Lee, 2014; Phipps, Burton, Osberg, & Lethbridge, 2006; Wells, Evans, Beavis, & Ong, 2010) as well as aggregate neighborhood socio-economic status (Grow et al., 2010; Nau et al., 2015; Rossen, 2014). Individuals living in more rural areas and in areas that report high levels of distress show higher prevalence of childhood obesity (Bailey-Davis et al., 2012), again supporting the influence of the school/community setting seen in the 10th grade sample. While higher obesity levels are frequently documented in Hispanic and non-Hispanic Black children (Guerrero et al., 2015; Ogden et al., 2014; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2013), no differences by racial/ethnic group were seen in the current study, although FNPA scores did differ by racial group in the younger sample. The increased influence of school SES level on weight status in older children than in younger children may suggest that the exposure to a low income/high distress community may have larger influences over a longer period of exposure.

The current study does show that the FNPA may have lower utility in older children than in younger children in or near the age range of the original validation sample. This is not surprising due to changes that are seen in family dynamics and the influence of parents as children transition into adolescence and begin to prepare for adulthood (Buhrmester & Furman, 1987). While asserting their independence, youth may be more likely to have more control over their own physical activity, screen time, sleep
and dietary patterns in adolescence than they previously had at younger ages. Future work should examine the FNPA at additional ages between those surveyed here to determine when efficacy of the tool may begin to wane.

It should be noted that parent BMI risk displayed the most consistently significant influence on BMI% and BMI50 in both age groups, as it was significant in all final mixed models other than BMI% in 10th grade students. This supports a wealth of previous research that has found strong associations between parent and offspring weight status (Fogelholm, Nuutinen, Pasanen, Myöhänen, & Säätelä, 1999; Lori A Francis, Lee, & Birch, 2003; Schaefer-Graf et al., 2005; Semmler, Ashcroft, Jaarsveld, Carnell, & Wardle, 2009). These consistent findings highlight the need for a family-based approach to child obesity prevention and treatment. While a portion of the relationship between parent and child weight is likely genetic (Herbert et al., 2006), a portion can also be attribute to shared environment and shared behaviors (Maes, Neale, & Eaves, 1997; Wardle, Carnell, Haworth, & Plomin, 2008).

The current study is strengthened by the collection of child weight status through an objective and systematic manner and the consideration of socioeconomic status at both the family and school level. The use of a screening tool capturing a variety of aspects of the home environment rather than physical activity or diet alone helps to examine the relative influence of socioeconomic status on a number of factors. However, self-reporting a parent weight status and small sample size, particularly for 10th graders, are limitations that future work should address.
The current study supports the utility of the updated FNPA to identify overweight and obese youth, although this utility is stronger in younger children. Parent weight status appears to have a strong influence on child weight in both age groups, although the relative contribution of genetics and shared environment cannot be determined here and should be examined in future work. There is evidence of a significant socioeconomic influence on the quality of the home environment as it pertains to obesogenic behaviors. Specifically, food choices and screen time appear to be areas that are most disparate between high and low resource families suggesting that prevention efforts targeting these areas may be most warranted in these populations. Finally, future work should also examine the influence of the school/social environment on children and youth as this influence appears stronger in older children.

4.7 Tables and Figures

Table 4.1. Descriptive statistics by age group

<table>
<thead>
<tr>
<th>1st graders</th>
<th>Body Mass (kg)</th>
<th>Height (cm)</th>
<th>BMI</th>
<th>BMI Percentile</th>
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<td>All Students (n = 250)</td>
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<td>123.22 (5.8)</td>
<td>16.80 (3.4)</td>
<td>59.30 (30.6)</td>
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<tr>
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<table>
<thead>
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<th>10th graders</th>
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<th>BMI Percentile</th>
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Table 4.2a. FNPA scores by gender, family income, school SES level, and race in 1st grade students

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<th>Beverages</th>
<th>Restriction</th>
<th>Screen</th>
<th>Environment</th>
<th>Family PA</th>
<th>Child PA</th>
<th>Sleep</th>
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<td>SD</td>
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**Gender**

<table>
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<th>Food Choices</th>
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<th>Environment</th>
<th>Family PA</th>
<th>Child PA</th>
<th>Sleep</th>
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<td>6.81</td>
<td>5.89</td>
<td>6.90</td>
<td>6.71</td>
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<td>6.87</td>
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**Family Income**

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<th>Food Choices</th>
<th>Beverages</th>
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<th>Child PA</th>
<th>Sleep</th>
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**School SES Tertile**

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<th>Child PA</th>
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**Race**

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<td>6.58</td>
<td>3.73</td>
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*Significantly different from Low School SES group  ^Significantly different from boys  +Significantly different from <$20,000
Table 4.2b. FNPA scores by gender, family income, school SES level, and race in 10th grade students

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<th>Total FNPA</th>
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<th>Food Choices</th>
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<td>5.65</td>
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<tr>
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<td>6.11</td>
<td>5.55</td>
<td>6.32</td>
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<td>6.04</td>
<td>5.75</td>
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<td>4.06</td>
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<td>Non-White (n = 21)</td>
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<td>5.95</td>
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*Significantly different from Low School SES group  ^Significantly different from boys
Table 4.3. Correlations among FNPA constructs for 1st grade students

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<th></th>
<th>FNPA score (cubed)</th>
<th>Meals</th>
<th>Eating</th>
<th>Food Choices</th>
<th>Beverages</th>
<th>Reward and Restriction</th>
<th>Screen Time</th>
<th>PA Environment</th>
<th>Family PA</th>
<th>Child PA</th>
<th>Sleep</th>
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<td>.39*</td>
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<td>.65*</td>
<td>.51*</td>
<td>.41*</td>
<td>.70*</td>
<td>.55*</td>
<td>.54*</td>
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<td>.18*</td>
<td>.17*</td>
<td>.12</td>
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<td>.19*</td>
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<td>PA Environment</td>
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<td>.46*</td>
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*p < 0.05
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<th>Food Choices</th>
<th>Beverages</th>
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*p < 0.05
Table 4.5a. Results of regression analyses examining factors contributing to BMI% in first grade

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<tr>
<td>Individual Level</td>
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</tr>
<tr>
<td>FRPL%</td>
<td>0.09 (1.41)</td>
<td>0.07 (0.92)</td>
<td>0.04 (0.49)</td>
<td>0.01 (0.12)</td>
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<td>Race</td>
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<td>Gender</td>
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</tr>
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<td>Parent BMI</td>
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<td>4.02 (2.74)*</td>
<td>4.44 (2.89)*</td>
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</tr>
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<td>Family Income</td>
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*Indicates significance at p < 0.05

Table 4.5b. Results of regression analyses examining factors contributing to BMI50 in first grade

<table>
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<tr>
<th>BMI 50 First Grade</th>
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<th>Model 4</th>
</tr>
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<tbody>
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<td>Individual Level</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>FRPL%</td>
<td>0.04 (0.71)</td>
<td>0.02 (0.34)</td>
<td>0.04 (0.71)</td>
<td>0.09 (0.89)</td>
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<tr>
<td>Race</td>
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</tr>
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<td>Gender</td>
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<td>1.96 (0.72)</td>
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<tr>
<td>Parent BMI</td>
<td>3.15 (3.09)*</td>
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<tr>
<td>Family Income</td>
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*Indicates significance at p < 0.05
^Indicates nearing significance at p = 0.6
Table 4.6a. Results of regression analyses examining factors contributing to BMI% in 10th grade

<table>
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<th>BMI Percentile</th>
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<tr>
<td>Individual Level</td>
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</tr>
<tr>
<td>FRPL%</td>
<td>0.61 (2.71)*</td>
<td>0.60 (2.58)*</td>
<td>0.54 (2.25)*</td>
<td>0.55 (2.20)*</td>
</tr>
<tr>
<td>Race</td>
<td>-0.05 (-0.01)</td>
<td>2.94 (0.41)</td>
<td>2.97 (0.41)</td>
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</tr>
<tr>
<td>Gender</td>
<td>4.72 (0.90)</td>
<td>5.81 (1.05)</td>
<td>5.92 (1.04)</td>
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</tr>
<tr>
<td>Parent BMI</td>
<td>3.36 (1.50)</td>
<td>3.37 (1.50)</td>
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<td></td>
</tr>
<tr>
<td>Family Income</td>
<td>-1.60 (-0.69)</td>
<td>-1.62 (-0.69)</td>
<td>0.04 (0.11)</td>
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<td>FNPA Score</td>
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*Indicates significance p < 0.05

Table 4.6b. Results of regression analyses examining factors contributing to BMI50 in 10th grade

<table>
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</tr>
<tr>
<td>Individual Level</td>
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</tr>
<tr>
<td>FRPL%</td>
<td>0.66 (3.07)*</td>
<td>0.64 (2.94)*</td>
<td>0.60 (2.71)*</td>
<td>0.54 (2.40)*</td>
</tr>
<tr>
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<td>0.50 (0.08)</td>
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<tr>
<td>Gender</td>
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<td>9.24 (1.82)</td>
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</tr>
<tr>
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<td>5.25 (2.57)*</td>
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<tr>
<td>Family Income</td>
<td>-1.54 (-0.73)</td>
<td>-1.35 (-0.63)</td>
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</tr>
<tr>
<td>FNPA Score</td>
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<td>-0.34 (-0.98)</td>
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Figure 4.1. Weight category distribution by grade and gender

4.8 References


CHAPTER 5. LONG-TERM PREDICTORS OF CHILD GROWTH PATTERNS
For submission to The American Journal of Public Health

Karissa L. Peyer and Gregory J. Welk

5.1 Abstract

Background: The high prevalence of child and adolescent obesity, as well as the racial/ethnic and socioeconomic disparities in obesity rates, are major public health concerns. A multitude of influences contribute to obesity risk for youth, including both demographic factors such as race and behavioral factors such as parent behaviors. However, few longitudinal studies have examined the influence of home and social factors on the progression of obesity. The purpose of the current study is to document growth trajectories from childhood to adolescent and identify factors that influence these trajectories.

Methods: The current study was a follow-up evaluation of a longitudinal cohort of 1st grade students (n = 837) first established in 2005/2006. In the original study, parents completed demographic surveys and the Family Nutrition and Physical Activity (FNPA) screening tool that assesses the home environment for obesity risk factors. Body mass index (BMI) was measured through school FITNESSGRAM participation. Contact was re-established with parents when students were in 10th grade and surveys were again administered and linked, via student ID number, to BMI information from 1st, 2nd, 8th, and 10th grade. Baseline FNPA as well as 1st grade and 10th grade BMI were available for 256 students. BMI was converted to age- and gender-specific BMI percentiles (BMI%) and BMI50 scores, which reflects the distance from the BMI for the 50th percentile. Growth curve analyses were conducted with SAS PROC TRAJ and hierarchical linear models to identify factors that influence growth patterns. General linear models were used to evaluate impact of baseline FNPA score, change in FNPA score (n = 58) and change in
parent BMI risk score (n = 48) on 10\textsuperscript{th} grade weight status. Results: Baseline FNPA score was not a significant predictor of 10\textsuperscript{th} grade BMI\% or BMI\textsubscript{50} when controlling for 1\textsuperscript{st} grade values. Growth curve analyses showed that parent weight status, low family income, being non-White, and attending a low socioeconomic-level school led to increased weight in 10\textsuperscript{th} grade, although results differed between BMI\% and BMI\textsubscript{50}. Change in FNPA score from 1\textsuperscript{st} to 10\textsuperscript{th} grade was a significant predictor of 10\textsuperscript{th} grade BMI\% and BMI\textsubscript{50} values. Conclusions: Racial and economic variables had a significant impact on growth trajectories from 1\textsuperscript{st} grade to 10\textsuperscript{th} grade, while smaller impacts were found for the home environment. Additional research is needed to examine the differential impact of these factors when the outcome is captured as BMI\textsubscript{50}.

5.2 Introduction

The high prevalence of child and adolescent obesity has been identified as a major public health concern in the United States (Institute of Medicine, 2005) and across the world (World Health Organization, 2016). The concern stems largely from the strong evidence that obesity persists through the lifespan and increases future risk for diabetes and chronic disease. While genetics can play a role in weight status (World Health Organization, 1997), the increase in obesity levels has been too rapid and occurred over too short of a time span to be due to physiological changes in genetics or metabolism. Instead, the most likely culprits are changes in the social/physical environment and associated changes in lifestyle behaviors. Despite the attention, few conclusions have been reached about the progression of obesity early in life or the lifestyle factors that may predispose youth to become overweight or obese.
A number of factors have been linked to an increased risk for obesity including, but not limited to, parent weight status, socioeconomic status, eating behaviors, physical activity levels, screen time, and sleep hygiene. Excessive screen time, screens in the bedroom, and short sleep duration have been shown to increase a child’s odds of being obese (Pileggi, Lotito, Bianco, Nobile, & Pavia, 2013; Wethington, Pan, & Sherry, 2013), while higher levels of physical activity and lower caloric intake reduce odds of overweight and obesity (Patrick et al., 2004). Despite considerable research on these factors, most studies to date have been cross-sectional and have not evaluated how changes in these factors over time influence growth. Identification of risk factors that influence progression or maintenance of obesity is important for identifying potential targets for intervention.

It is well established that socio-economic status and other social determinants of health may explain health disparities in the population. Family income can limit access to healthy foods as well as impacting the safety of the neighborhood in which families live and their children play - or do not play due to safety concerns (Lovasi, Hutson, Guerra, & Neckerman, 2009). In fact, the social determinants of health are so important that creating “social and physical environments that promote good health for all” is one of the overarching goals of Healthy People 2020 (Secretary’s Advisory Committee on Health Promotion and Disease Prevention Objectives for 2020, 2010). The Healthy People 2020 approach to address these social determinants focuses on five key areas: economic stability, education, social and community context, health and health care, and neighborhood and built environment. While these areas have large public health implications, they have limited modifiability for individuals and families and so
identifying more malleable factors that could be targeted with traditional intervention approaches is also warranted.

Parenting practices and home environments are known to exert strong influences on children’s lifestyle behaviors (particularly physical activity and eating habits) (Arredondo et al., 2006; Krahnstoever Davison, Cutting, & Birch, 2003; Joyce & Zimmer-Gembeck, 2009). Parents serve as local policy makers by determining children’s access to physical activity opportunities, governing their exposure to types and amounts of food, and setting home policies (or lack thereof) in regards to access to and amount of screen time undertaken. These are all areas where substantial research has shown an influence of behavior on risk for overweight and obesity (Abbott & Davies, 2004; Arredondo et al., 2006; Crespo et al., 2001; Krahnstoever Davison & Birch, 2002; Krahnstoever Davison et al., 2003; Dennison, Erb, & Jenkins, 2002; Ekelund et al., 2006; Grund, Krause, Siewers, Rieckert, & Müller, 2007; Jago, Baranowski, Baranowski, Thompson, & Greaves, 2005; Joyce & Zimmer-Gembeck, 2009; Laurson et al., 2008; Moore et al., 2003; Ortega, Ruiz, & Sjöström, 2007; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003; Wake, Hesketh, & Waters, 2003). Due to the influence of these behaviors on obesity risk, a tool to capture these various aspects in an efficient manner is important for assessment, prevention and treatment approaches.

The Family Nutrition and Physical Activity (FNPA) screening tool was designed to detect practices and environments in the home that may increase a child’s risk for becoming overweight. The screening tool was developed through a comprehensive evidence analyses of factors shown to predict risk of childhood obesity (Ihmels et al., 2007). It specifically captures 10 different constructs that had documented evidence for

Initial validation studies of the FNPA showed that it predicted one-year changes in BMI (Ihmels, Welk, Eisenmann, Nusser, & Myers, 2009) but longer-term follow-up studies have not been completed. It would be valuable to know whether environments and practices in early childhood influence BMI trajectories as children move into middle school and high school. It is logical to hypothesize that parental involvement in eating, screen time, and physical activity may be lower in older children so the relationship between these FNPA constructs and BMI may also change. This study will directly examine these issues by examining longitudinal patterns in BMI from the original FNPA cohort. The study will address each of the following questions: 1) What is the general growth trajectory from first through 10th grade in this sample? 2) Does the baseline FNPA score predict long-term weight status changes over 9 years? and 3) Do changes in the home environment from childhood to adolescence, captured by the FNPA, predict adolescent weight status?

5.3 Methods

5.3.1 Design and Sample

The study capitalizes on a database established through an ongoing participatory research agreement with a large Midwestern school district. Physical education teachers from across the district provide information about health related fitness based on the established FITNESSGRAM testing protocol and these data have been tracked over time.
In the original FNPA study conducted by Ihmels et al. (2009), parents of first graders in 2005/2006 were asked to complete the FNPA and to allow the data to be linked to their students BMI data obtained through the FITNESSGRAM data tracking initiative. The study compiled BMI data from 1775 first grade students (from 37 out of 39 elementary schools in the district) and parents of 837 of these students also completed the FNPA assessment.

Student fitness and BMI data has continued to be tracked intermittently over time using the same student ID numbers used in the original FNPA validation studies. This makes it possible to retrospectively examine longitudinal changes in BMI in this unique cohort. The present study merged additional BMI data, obtained when this cohort was in the 2nd and 8th grade, with baseline data and current (10th grade) BMI information. There was considerable attrition and movement in and out of the district over the subsequent years, but a significant portion of the original sample remained in the district over the 9-year period. Parents from the original sample of youth still living in the district were re-recruited via survey packets sent through the mail.

The project was approved by the Institutional Review Board of Iowa State University (Appendix C) and the participating school district.

5.3.2 Assessments and Data Processing

5.3.2.1 Collection and Processing of Survey Data: Parents in the targeted sample were mailed survey packets including informed consent, FNPA surveys, a modified version of the USDA U.S. Household Food Security Survey Module (Appendix H), and a demographic survey. The FNPA tool has undergone significant alterations since the original validation study to take into account changes in relevance of certain constructs.
For example, the presence of a TV in a bedroom was a strong predictor of excess sedentary viewing when the original instrument was developed, but TV’s have largely been replaced by tablets and computers that stream media and video. Other changes took into account feedback from past participants about wording of specific items. For instance, the item asking about family meals has been changed to assess times when the child in question eats a meal with at least one other family member, but not necessarily the whole family, to allow for situations when, for example, a sibling might be at a sport practice or club meeting. In order to evaluate the current version of the tool and also allow for comparison with the original tool (and evaluation of changes over time), it was important for parents to complete both the original and updated version of the tool at follow-up. Scores on both versions of the FNPA were calculated by summing scores for all items (21 items on the original, 20 items on the updated version) including reverse-coding for a number of items. Additionally, scores for each of the ten constructs were calculated by summing the items within each construct.

The USDA U.S. Household Food Security Survey Module (Economic Research Service, 2012) asks respondents about foods eaten in their household in the last 12 months. It is generally administered as an interview, but was converted to a written survey for the present study. Questions assess the ability of the household to buy the amount and kinds of food desired, concern over lack of money to buy (healthy) food, and any occurrences of hunger, limiting food intake, or not eating on the part of both adults and children within the household. From these items, scores for household, adult, and child food insecurity are calculated.
The demographic survey included information about parent age, gender, race, and education level; household income; and height and weight for both mother and father. School-level participation (% of students) in the national free- and reduced price lunch program (FRPL%) was obtained from publicly available sources and used as a proxy for school-level socioeconomic status.

5.3.2.2 Collection and Processing of BMI Data: De-identified (school ID number only) age, gender, and anthropometric data were provided by the school district, allowing for matching of FITNESSGRAM data to parent surveys.

BMI percentile (BMI%) for age and gender was calculated from gender, height, weight, and age at test date using standard CDC SAS codes. BMI was also converted to BMI50, an additional measure of weight status that corrects for some of the issues that have been detected in using BMI%, particularly for capturing changes in weight status (Cole, Faith, Pietrobelli, & Heo, 2005; Paluch, Epstein, & Reommich, 2007). Due to the flattening of the BMI% curve at the high and low ends of the curve, risk for children at the high end of the weight distribution may be underestimated. For example, if a child is already at the 99.9th percentile, any increase in weight will not be reflected in assessing change in BMI% since this number cannot exceed 99.9%. BMI50, also known as Percent over BMI (Paluch et al., 2007) calculates the difference between an individual’s measured BMI and the BMI value for the 50th percentile for age and sex and then creates a percentage to reflect this difference by dividing by the BMI value for the 50th percentile. BMI50 can be calculated by comparing measured BMI to the 50th percentile using the following formula:

\[ \text{BMI50} = \frac{\text{child BMI} - \text{BMI for 50th percentile}}{\text{BMI for 50th percentile}} \times 100 \]
Mother and father BMIs were used to calculate a Parent BMI Risk Score. Underweight and normal-weight parents received a score of zero, overweight parents a score of 1 and obese parents a score of two. These scores were then summed to create a total Parent BMI Risk score for each child.

5.4 Data Analyses

Descriptive statistics and prevalence of overweight and obesity for children were calculated. Two approaches to growth curve models were used to evaluate BMI trajectories throughout childhood using data provided through the FITNESSGRAM battery. One approach involved the use of SAS PROC TRAJ to model overall patterns of growth using the longitudinal BMI data. The TRAJ procedure clusters observations into groups based on similarities in growth trajectories, similar to latent growth class analyses. It then allows for modeling of likelihood for assignment to these trajectory groups (compared to a reference group) based on model-specified risk factors (Jones, Nagin, & Roeder, 2001; Jones & Nagin, 2007). Models for the PROC TRAJ approach were run twice: once for all available BMI percentile measurements and a second model for the smaller sample that also had FNPA scores available at baseline.

The second approach involved the use of a two-level hierarchical linear model (SAS PROC MIXED), with multiple observations nested in children over time. The level one parameters (BMI, time) were modeled as a function of level two (person) variables sex, race, family income, school SES level, Parent BMI Risk Score and FNPA score. The hierarchical analysis was conducted using both BMI% and BMI50 as the outcome
variable. However, PROC TRAJ does not support outcome variables with negative values, and so it was not possible to use this approach to analyze BMI50 trajectories.

General linear models were used to evaluate the impact of FNPA score, changes in FNPA score and Parent BMI Risk score on weight status in 10th grade, controlling for weight status at baseline. These analyses were conducted using both BMI% and BMI50 as the outcome variable. Change in FNPA score was calculated by subtracting the baseline FNPA score from the 10th grade FNPA score, using the original survey version for both time points. Change in Parent BMI Risk score was calculated by subtracting the baseline Parent BMI Risk from that in 10th grade.

Supplemental analyses were conducted to examine the impact of household food insecurity on BMI% and FNPA score. Respondents were divided into those that were food secure (USDA Household insecurity = 0) and those displaying any level of food insecurity. T-tests were performed between to determine whether these two groups differed on BMI%, BMI50, FNPA score, or score for any of the ten FNPA constructs. Small sample and low variability did not allow for the examination of gradations of food security.

5.5. Results

A total of 256 students from 36 of the 37 elementary schools measured at baseline had baseline FNPA scores as well as BMI measurements at the two time points of primary interest – 1st grade and 10th grade. Because of the large turnover, it was important to test if there was differential dropout or transfers of youth from lower SES schools. Analyses revealed that the likelihood of 10th grade BMI data was not influenced by baseline school SES level, race, or baseline family income (p > 0.05) with 26.4% of
students from baseline high SES schools and 34.0% of students from baseline low SES schools having 10th grade BMI data. This suggests that the available sample is at least generally representative of the overall sample that were tested at the first time point. Participant flow is diagramed in Figure 5.1.

The demographics of the sample are provided reported in Table 5.1. Due to relatively small samples in non-White/Caucasian racial/ethnic groups, all non-White groups were combined for subsequent analyses. School SES level varied greatly with anywhere from 7.4% to 89.8% of students at a school eligible for the free- and reduced-price lunch program. Surveys were returned by 220 parents of 10th graders from the original cohort (student with BMI at baseline). Of these, 121 had FNPA at baseline and 99 had BMI in 10th grade. Of these, fifty-eight students had both FNPA and BMI available from both 1st grade and 10th grade.

The distribution of weight categories by age and genders for the 256 students with baseline FNPA and both 1st grade and 10th grade BMI is shown in Figure 5.2. Briefly, 42.5% of boys and 36.1% of girls were overweight or obese at baseline while 44.8% of boys and 47.5% of girls were overweight or obese at follow-up. There were no significant differences in weight categories at either time point by racial/ethnic group or between genders (p = 0.21-0.85).

5.5.1 Results with General Linear Models

General linear models were used to determine whether the childhood FNPA score (1st grade) was a significant predictor of weight status in adolescence (10th grade). Baseline FNPA score was not a significant predictor of BMI percentile in 10th grade (p = 0.08),
although results were slightly stronger when evaluating the FNPA score using BMI50 as
the outcome. Baseline FNPA score was a significant predictor of 10th grade BMI50 (p =
0.004) but was no longer significant when BMI50 from first grade (p < 0.0001) was
added to the model (p = 0.12).

5.5.2 Growth Curve Results – Proc Traj

A second goal of the study was to examine general growth patterns in the cohort
established during the initial development of the FNPA. The SAS Proc Traj procedure
was used to evaluate overall growth trajectories from 1st grade to 10th grade within the
full sample of 1775 students with first grade BMI percentile. Of these, 1618 also had 2nd
grade BMI, 474 had measures in 1st, 2nd, and 8th grade, and 195 students had BMI
measurements at all time points. This analysis showed an increase in average BMI
percentile from approximately 68% in first grade to just under 71% in 10th grade (Figure
5.3).

An advantage of the Proc Traj approach is that it allows common patterns of growth
to be identified and examined. This approach groups individuals base on similarities in
trajectory shapes and then estimates the likelihood of belonging to a specific trajectory
group based on the presence (or lack thereof) of model-specified risk factors. The current
analysis examined a variety of options for group numbers and growth trajectory patterns
(linear, quadratic and cubic) for all individuals with BMI measures and identified a 6-
group model as the best interpretable model for growth trajectory groups. The largest
proportion of students (Group 6: 44.0%) were allocated to the trajectory group that
started high (approximately the 90th percentile) and stayed high. Only 7.5% of students
were allocated to the group that started low (approximately the 15th percentile) and stayed low (Group 1). The rest of the students were allocated to groups that started between the 30th and 80th percentile and either increased (Group 2: 7.4%, Group 3: 16.8%) or decreased (Group 4: 12.1%, Group 5: 12.1%) over time. For this large group analysis, the only covariates examined were gender and school-level socioeconomic status, captured by the percentage of students eligible for the national free- and reduced price lunch (FRPL) program. PROC TRAJ analyses revealed that students attending schools in the highest quartile of FRPL participation (low SES) had increased likelihood of belonging to Group 2 (estimate 0.88, p = 0.02 and Group 6 (estimate 0.78, p = 0.005), compared to likelihood of belonging to Group 1 (Figure 5.4a). Gender did not influence Group membership (p > 0.16).

Additional PROC TRAJ analyses with the subgroup of students having FNPA and other demographic predictors collected at baseline (n = 837) revealed similar trajectory groups, although a smaller percentage of student were allocated to the group that started high and stayed high (Group 6: 38.3%) and a larger percentage were allocated to the group that started low and stayed low (Group 1: 9.7%), suggesting that the cohort group may be slightly leaner than the full sample. The rest of the students were allocated to groups that started between the 40th and 75th percentile and either increased (Group 2: 8.8%), decreased (Group 3: 10.5%, Group 4: 13.2%), or stayed relatively stable (Group 5: 19.5%) over time (Figure 5.4b).

When risk factors were evaluated in the model, having a baseline FNPA score in the lowest quartile or being female (compared to male reference) did not significantly impact likelihood of group membership. However, having an overweight mother, overweight
father, being non-white, attending a low SES school (highest tertile of FRPL participation) or having a low family income (< $25,000 per year) did affect likelihood of group membership. Table 5.2 contains the likelihood estimates that the presence of a risk factor confers for an individual belonging to that particular group compared to the reference group (Group 1).

5.5.3 Growth Curve Results – Hierarchical Linear Models

Hierarchical Linear Models were also used to assess the influence of gender, race, school SES, FNPA score, parent weight status, and income on growth patterns. Similar to PROC TRAJ analyses, these models also indicated the importance of parent BMI, income and race; however, model results differed between BMI% and BMI50, possibly due to the ability of each measure to capture change over time at different parts of the standard BMI growth curve (Table 5.3). In the BMI% model, there were significant effects of gender and race on change in BMI% over time (p = 0.01 and 0.03, respectively). Race also had a significant influence on baseline BMI% with non-White children having higher BMI% in 1st grade compared to White/Caucasian students (p = 0.04). There was no consistent change in BMI% across students by year (p-value for Time = 0.30). Parent BMI Risk significantly influenced BMI% at baseline (p = 0.01) but did not influence change in BMI% (p = 0.23).

In the BMI50 model, there was a significant impact of time (p < 0.01). There were also significant impacts of School SES level (p < 0.01) and income (p < 0.01) on starting BMI50 score and significant impacts of race (p = 0.01) and Parent BMI Risk score (p = 0.01) on change in BMI50. Non-White children showed faster increases in BMI50 than
White/Caucasian students. Children with at least one obese parent or two overweight parents (Parent BMI Risk score = 2 or higher) had faster increases in BMI50 when compared to students with two normal-weight parents (p < 0.01).

5.5.4 Results of General Linear Models for Change Variables

The majority of the variables evaluated in the growth trajectory models were only captured at baseline. However, in the subsample of 58 students that had both FNPA and BMI available at both 1st and 10th grade, change in variables could be evaluated for their impact on 10th grade BMI variables. There was a significant correlation between baseline and 10th grade FNPA score in this subsample (r = 0.58, p < 0.001), similar to that seen in the group that had surveys at both points but no 10th grade BMI data available (n = 118, r = 0.59, p < 0.001), suggesting that changes in home environment did not influence the availability of BMI information at follow-up. For this subsample, the average FNPA score was 46.7 in 1st grade and 44.1 in 10th grade. Change in FNPA score (a positive change score represents an increase in FNPA score) from 1st to 10th grade was a significant predictor of 10th grade BMI% (B = -2.4, p = 0.007) and 10th grade BMI50 (B = -1.7, p = 0.02) even when controlling for baseline BMI values.

This impact was not seen for change in Parent BMI Risk score. Complete parent BMI and student BMI data were available for 48 students. This number is smaller than that used to evaluate FNPA change often due to the height and weight of one parent not being reported at follow-up. Of these 48, twenty-three showed no change in Parent BMI Risk score, five showed improvement, and twenty showed worsening of Parent BMI Risk from 1st grade to 10th grade. However, this change score was not associated with either
BMI% (B = -1.9, p = 0.59) or BMI50 (B = -0.7, p = 0.82) when controlling for baseline BMI values.

5.5.5 Results of Food Security Analyses

Household and child food security were not significantly correlated with BMI%, BMI50 (r = 0.15, p = 0.14 and r = 0.07, p = 0.50, respectively) or FNPA score (r = -0.08, p = 0.42 and r = -0.09, p = 0.40, respectively) in 10th grade. Evaluation of the ten FNPA constructs did show differences in scores between food secure and insecure houses for Food Choices (p = 0.007). No other construct scores differed between these two groups.

5.6 Discussion

Given the recent public health concern over the tracking of obesity throughout the lifespan, it is important to identify factors that increase risk for childhood and adolescent obesity. In the current evaluation, the FNPA score in 1st grade, a measure of the obesogenic nature of the home environment, was a significant predictor of BMI50 in 10th grade, but this significance was removed once baseline BMI50 was added to the model. This finding suggests that while home environment is important for obesity risk throughout childhood and adolescence, early weight status is an extremely strong predictor of later weight status. While this is not surprising, given the strong evidence of tracking of weight status across one’s life (Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; Guo, Wu, Chumlea, & Roche, 2002; Sun et al., 2008; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), it may also suggest that it is the home environment during childhood, more than during adolescence, that shapes obesity risk.
The current results support previous evidence of a strong influence of socioeconomic and family influences on obesity risk. Based on the latent growth pattern analyses (PROC TRAJ), both low individual family income and poor school-level economic status significantly increased a child’s risk of having a high weight status in first grade. This is consistent with previous research (Chatterji, Lahiri, & Song, 2011; Grow et al., 2010; Lee, Andrew, Gebremariam, Lumeng, & Lee, 2014; Nau et al., 2015; Phipps, Burton, Osberg, & Lethbridge, 2006; Rossen, 2014; Wells, Evans, Beavis, & Ong, 2010). Additionally, low school SES increased the odds of a child maintaining a high weight status from childhood through adolescence. Recent research comparing the influence of family- and neighborhood-level socioeconomic influence has demonstrated that, while a higher family income is protective against obesity in low-deprivation neighborhoods, this protective effect is eliminated in high-deprivation neighborhoods (Rossen, 2014), which supports the influence of school SES found in the current analyses. Due to the increased likelihood of an obese child growing into an obese adult (Freedman et al., 2001; Guo et al., 2002; Whitaker et al., 1997), these economic disparities warrant great attention in public health attempts to control child obesity rates.

Parent overweight and obesity also had strong relationships with child growth over time. Parent BMI has repeatedly been shown to be a strong predictor of child weight (Fogelholm, Nuutinen, Pasanen, Myöhänen, & Säätelä, 1999; Francis, Lee, & Birch, 2003; Schaefer-Graf et al., 2005; Semmler, Ashcroft, Jaarsveld, Carnell, & Wardle, 2009), although this is likely to be through both shared genetics and shared environments and behaviors, learned by children from their parents. In the current study, change in parent weight status did not significantly influence 10th grade BMI% or BMI50. This is
particularly noteworthy given that nearly half of parents showed an increase in BMI risk score, meaning that the increase in weight that is often seen during middle age (Clarke, Malley, Johnston, & Schulenberg, 2009; Malhotra, Østbye, Riley, & Finkelstein, 2013) does not confer additional obesity risk to children of parents who experience this weight gain.

There are well-documented disparities in obesity by racial/ethnic groups, although these disparities are often eliminated after controlling for additional sociodemographic factors (Guerrero et al., 2015; Rossen, 2014; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2013). In the current study, there were no differences in overweight or obesity risk by race at either baseline or follow-up; however, race did play a significant role in growth trajectories. In both BMI% and BMI50 models, children identified as non-White showed steeper increases compared to White/Caucasian youth. This is despite the inclusion of family- and school-level SES in these models. This highlights the need for additional longitudinal analyses for the interaction between factors such as race and socioeconomic status when it comes to identifying disparate risk for obesity.

It is important to note that, while baseline FNPA score did not predict 10th grade BMI measures once baseline BMI was controlled for, change in FNPA score did. This finding provides support for the use of the FNPA as a clinical tool with which providers can capture changes in the home environment that may influence obesity risk. The use of the FNPA in well-child visits as a brief assessment of the home environment has been shown to be acceptable to both patients and providers and use of the FNPA in motivational interviewing approaches to behavior change have resulted in patient lifestyle
change (Christison et al., 2014). The current results support the repeated administration of the FNPA to capture change in home obesity risk.

The majority of studies that have examined youth growth trajectories across time have done so using age- and gender-specific BMI percentile standards (Flegal, Carroll, Kit, & Ogden, 2012; Fryar, Carroll, & Odgen, 2012; Ogden, Carroll, & Flegal, 2008; Ogden, Carroll, Kit, & Flegal, 2014; Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995); however, previous work has demonstrated limitations of the BMI% approach and proposed use of Percent Over BMI (referred to as BMI50 in this study) (Cole et al., 2005; Paluch et al., 2007). The current study identifies many analyses where results differ based on the selected measure of weight status. In the mixed model analyses, no significant influence of Time was identified when examining growth patterns using BMI%, while BMI50 did show significant changes over time. These results suggest that BMI50 may be a more sensitive measure to capture change in weight status. Additionally, different covariates demonstrated significant effects on changes in weight status over time between the BMI% and BMI50 models. While a significant Race*Time interaction was seen for both BMI% and BMI50, Parent BMI Risk score had a significant interaction with time in the BMI50 model but not in the BMI% model. These differences bear further investigation as the difference in weight variable influenced the identification of significant factors for change over time in the current study and so may influence the findings of future longitudinal work examining obesity risk factors.

The current study has several strengths. It documents a long-term follow-up in a significantly sized sample, with over 250 students having baseline FNPA score and BMI at both 1st grade and 10th grade. It is also noteworthy that the availability of follow-up
data was not negatively influenced by socioeconomic status or race, improving the representativeness of the sample. The study documents the influence of a number of factors, both at the individual and school-level, on growth trajectories over time and also examines how changes in home environment and changes in parent weight may influence growth patterns.

It is important to note that levels of overweight and obesity were higher in the current sample than in recent national surveys (Ogden et al., 2014) and this may limit the translatability of the current findings to leaner samples. The lack of survey data at follow-up must also be considered, with collection of FNPA information from 121 of the 837 students with baseline FNPA (14.5%). However, given the 9-year timespan of the study and allowance for movement in and out of the school district, attrition was unavoidable.

In summary, racial and economic variables had a significant impact on growth trajectories from 1st grade to 10th grade, while smaller impacts were found for the home environment. The current findings confirm the wealth of research showing that economic disadvantage results in an increased risk for obesity and other poor health outcomes. The differences in findings between BMI% and BMI50 show a critical need for further comparison of these methods and expanded consideration of the BMI50 measure for analyzing change in weight throughout childhood and adolescence. Future interventions to reduce prevalence of youth overweight and obesity should consider the discrepancies identified in this study and the strong influence of school- and community-level socioeconomic factors.
5.7 Tables and Figures

Table 5.1. Demographics of the sample with baseline FNPA and BMI% at 1st and 10th grade

<table>
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<tr>
<th>Sex</th>
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<td>Male</td>
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<td>31.54</td>
</tr>
<tr>
<td>$25,000-$50,000</td>
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<td>31.54</td>
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<td>Overweight</td>
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<td>Overweight</td>
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Table 5.2. Maximum likelihood estimates for group assignment based on risk factors

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<th>Estimate</th>
<th>p-value</th>
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<th>FNPA</th>
<th>OW</th>
<th>Mom</th>
<th>OW</th>
<th>Dad</th>
<th>Non-white</th>
<th>Low</th>
<th>Income</th>
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Bold and Italics indicates factors that significantly increase an individual’s likelihood of belonging to the group, compared to the Reference Group, Group 1.
Table 5.3. Hierarchical linear models for growth trajectory for BMI% and BMI50

<table>
<thead>
<tr>
<th>BMI% Growth Model</th>
<th>F value</th>
<th>p value</th>
<th>BMI50 Growth Model</th>
<th>F value</th>
<th>p value</th>
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<td>Time</td>
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<td>School SES</td>
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<td>0.0015</td>
</tr>
<tr>
<td>School SES*time</td>
<td>3.71</td>
<td>0.0543</td>
<td>School SES*time</td>
<td>3.04</td>
<td>0.0813</td>
</tr>
<tr>
<td>Gender</td>
<td>0.57</td>
<td>0.4522</td>
<td>Gender</td>
<td>3.13</td>
<td>0.0774</td>
</tr>
<tr>
<td>Gender*time</td>
<td>6.04</td>
<td>0.0142</td>
<td>Gender*time</td>
<td>0.57</td>
<td>0.4517</td>
</tr>
<tr>
<td>Race</td>
<td>4.35</td>
<td>0.0374</td>
<td>Race</td>
<td>0.53</td>
<td>0.4667</td>
</tr>
<tr>
<td>Race*time</td>
<td>4.86</td>
<td>0.0276</td>
<td>Race*time</td>
<td>6.42</td>
<td>0.0126</td>
</tr>
<tr>
<td>Income</td>
<td>1.26</td>
<td>0.2840</td>
<td>Income</td>
<td>5.15</td>
<td>0.0060</td>
</tr>
<tr>
<td>Income*time</td>
<td>1.93</td>
<td>0.1456</td>
<td>Income*time</td>
<td>2.04</td>
<td>0.1309</td>
</tr>
<tr>
<td>ParentBMIRisk</td>
<td>3.13</td>
<td>0.0145</td>
<td>ParentBMIRisk</td>
<td>2.30</td>
<td>0.0573</td>
</tr>
<tr>
<td>ParentBMIRisk*time</td>
<td>1.42</td>
<td>0.2259</td>
<td>ParentBMIRisk*time</td>
<td>3.22</td>
<td>0.0122</td>
</tr>
<tr>
<td>BaselineFNPA</td>
<td>0.42</td>
<td>0.5189</td>
<td>BaselineFNPA</td>
<td>1.13</td>
<td>0.2887</td>
</tr>
<tr>
<td>BaselineFNPA*time</td>
<td>0.43</td>
<td>0.5098</td>
<td>BaselineFNPA*time</td>
<td>2.79</td>
<td>0.0954</td>
</tr>
</tbody>
</table>
Figure 5.1. Participant flow through follow-up

Figure 5.2. Weight category distributions by grade and gender
Figure 5.3. Overall growth trajectory for all participants with 1st grade BMI and follow-up

Figure 5.4a. Growth rate groups for all participants with BMI data

Figure 5.4b. Growth rate groups for participants with BMI and survey data
5.8 References


Secretary’s Advisory Committee on Health Promotion and Disease Prevention Objectives for 2020. (2010). *Healthy People 2020: An opportunity to address the social determinants of Health in the United States*.


CHAPTER 6. CONCLUSIONS

The high prevalence of overweight and obesity in children and youth has vast implications for health and well-being. Research into the causes and contributors to the obesity epidemic have examined a wide-ranging array of factors including race, socioeconomic status, and behaviors including physical activity, nutrition, sleep, screen time and sedentary behaviors. However, current treatment approaches to obesity are largely initiated only after weight has already reached a problematic level and little evidence is available on the factors that influence weight trajectories of youth over a substantial follow-up period. This dissertation was designed to fill these gaps in the literature by updating and examining the utility of the Family Nutrition and Physical Activity (FNPA) screening tool to identify home environments where risk factors may predispose youth to overweight and obesity. The study also examined the influence of other sociodemographic variables on weight status and weight trajectories from childhood to adolescence. Summaries of the three studies are provided below to provide an overall synopsis of the dissertation.

Study one (Chapter 3) was designed to test user responses to and psychometric properties of various versions of the FNPA. Cognitive interviews with parents completing the FNPA showed overall satisfaction with both the existing subjective response scale of the FNPA as well as the proposed objective alternative. However, parents provided clear feedback that the inclusion of "Recommended Practices" before FNPA items was not desirable and may lead to over-reporting of favorable behaviors on the tool. Quantitative comparison of the subjective and objective response scales provided support for the continued use of the subjective version. While mean scores did not differ between the two, the subjective version displayed between test-retest reliability and better inter-item
reliability. Confirming the finding of similar means between the two versions, there was
generally good agreement in category selection between the two versions with
participants who selected "6-7 days per week" on the objective version (the highest
response choice) being very likely (78.8%) to select "Always/Almost Always" (the
highest response choice) on the subjective version. Factor analysis supported the
retention of three factors in the current version of the survey: Food and Screen Time,
Physical Activity, and Sweets and Sleep. However, general weak loadings indicate that
there may not be justification of the FNPA into these factors for future analyses. The
current examination of the FNPA shows that the tool has been strengthened with these
updates as the current tool showed improved inter-item reliability compared to the initial
version. This study also provides evidence of the test-retest reliability of the FNPA, an
aspect that has not previously been examined. Our research team is currently working to
translate this updated version of the FNPA into Spanish for continued dissemination of
the tool and use in both research and clinical applications.

The FNPA has been evaluated and applied primarily in populations of elementary
school children but has not been evaluated in adolescents. The influence of parenting
behaviors and the home environment may have less influence on obesity risk in older
youth than in children. The second study (Chapter 4) examined the construct validity of
the FNPA in two age samples: 1st grade and 10th grade youth. This study also examined
the influence of socioeconomic status (SES) and race on overweight/obesity risk. Scores
on the FNPA were higher in the 1st grade sample and also differed by school SES level
(measured by percentage of students eligible for the national Free and Reduced Lunch
Program (FRLP)). FNPA score was weakly but significantly correlated with BMI
percentile (BMI%) and BMI50 in 1st graders. Additionally, the odds of overweight/obesity were significantly higher for children in the lowest tertile of FNPA score compared to children in the highest tertile, although this relationship was rendered insignificant when parent BMI risk was added to the analysis. The relationships between FNPA and BMI were weaker in the 10th grade sample with odds of overweight/obesity not significantly impacted by FNPA score. In the 10th grade sample, gender and school SES also had a significant influence on BMI50. This study highlighted the shift in influence of various risk factors for overweight/obesity as children age. While the influence of parents and the home environment appears to decrease as children mature, the influence from school/social economic factors appears to increase. This suggests that different factors may need to be targeted to address obesity risks at different age groups.

Study three (Chapter 5) built on the previous studies in the dissertation by moving from cross-sectional analyses to longitudinal analyses to examine the factors that impact growth trajectories from childhood to adolescence. Results from this study show that parent BMI risk, family income, race, and school SES all influence growth trajectories from 1st to 10th grade. Specifically, Black/African American and Hispanic/Latino youth showed steeper increases in BMI50 and BMI% (Black/African American only) than White/Caucasian youth and individuals from both low-income families and low-SES schools significantly influenced BMI status. Further, in the BMI50 model, there was a significant interaction between family income and school SS with children from low-income families attending low-SES schools showing the steepest increase in BMI50. While 1st grade FNPA score was not a significant predictor of weight status, change in FNPA score from 1st to 10th grade did predict 10th grade BMI% and BMI50, even when
controlling for 1st grade BMI, suggesting an impact of the change in home environment quality. This evidence suggests that improving the home environment and behaviors assessed by the FNPA - or even just preventing declines - may reduce risk for overweight/obesity in the teenage years.

Collectively, this dissertation supports the utility of the FNPA as a screening tool for obesity risk in younger children, although it does not appear to be as useful in older youth. The FNPA shows acceptable psychometric properties and acceptability by parents as well as the ability to identify overweight/obese children. While FNPA score is not as tightly associated with weight status in adolescents, the change in FNPA score was clearly associated with changes in adolescent BMI changes. The included studies also provide additional research of the influence of parent weight and socioeconomic status on child obesity risk. These associations help to explain the nature of disparities in obesity rates and the inherent challenges in promoting prevention at the population level. While the dissertation provides evidence of the strengths of the FNPA and its association of obesity risk, further research is needed to examine both the FNPA and other risk factors identified by the current studies. Recommendations for future work include evaluation in age groups between those measured in the present studies, evaluation of the FNPA as a clinical motivational interviewing and counseling tool, and the relative efficacy of this counseling in diverse racial and socioeconomic groups.
APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL FOR
STUDY 1/CHAPTER 3

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515-294-4566
FAX 515-294-4207

Date: 6/19/2014
To: Karissa Peyer
283 Forker Bldg

CC: Dr. Gregory J Welk
257 Forker Bldg

From: Office for Responsible Research
Title: Evaluation of the FNPA
IRB ID: 14-111

Approval Date: 6/17/2014
Date for Continuing Review: 3/3/2016
Submission Type: Modification
Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.

- Retain signed informed consent documents for 3 years after the close of the study, when documented consent is required.

- Obtain IRB approval prior to implementing any changes to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.

- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.

- Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.

- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. Approval from other entities may also be needed. For example, access to data from private records (e.g., student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. IRB approval in no way implies or guarantees that permission from these other entities will be granted.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don’t hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.
Date: 1/21/2015
To: Karissa Peyer
263 Forker Bldg
From: Office for Responsible Research
Title: The Use of FNPA in Schools
IRB ID: 14-372

Approval Date: 1/20/2015
Date for Continuing Review: 8/7/2016
Submission Type: Modification
Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 50), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
- Retain signed informed consent documents for 3 years after the close of the study, when documented consent is required.
- Obtain IRB approval prior to implementing any changes to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.
- Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. Approval from other entities may also be needed. For example, access to data from private records (e.g., student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. IRB approval in no way implies or guarantees that permission from these other entities will be granted.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don’t hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.
APPENDIX C: INSTITUTIONAL REVIEW BOARD APPROVAL FOR STUDY 3/CHAPTER 5

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Date: 1/16/2015
To: Karissa Peyer
283 Foraker Bldg

CC: Dr. Gregory J Weik
257 Foraker Bldg

From: Office for Responsible Research

Title: FNPA Cohort Study

IRB ID: 14-370

Approval Date: 1/16/2015
Date for Continuing Review: 8/7/2016

Submission Type: Modification
Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 50), please be sure to:

1. Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
2. Retain signed informed consent documents for 3 years after the close of the study, when documented consent is required.
3. Obtain IRB approval prior to implementing any changes to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
4. Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.
5. Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
6. Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. Approval from other entities may also be needed. For example, access to data from private records (e.g., student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. IRB approval in no way implies or guarantees that permission from these other entities will be granted.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don’t hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.
### APPENDIX D: GRADING THE STRENGTH OF THE EVIDENCE FOR A CONCLUSION STATEMENT

<table>
<thead>
<tr>
<th>Strength of Evidence Elements</th>
<th>Grades</th>
<th>II Fair</th>
<th>III Limited/Weak</th>
<th>IV Expert Opinion Only</th>
<th>V Grade Not Assignable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality; Scientific rigor/validity; Considers design and execution</td>
<td>Studies of strong design for question. Free from design flaws, bias and execution problems</td>
<td>Studies of strong design for question with minor methodological concerns, OR only studies of weaker study design for question</td>
<td>Studies of weak design for answering the question OR inconclusive findings due to design flaws, bias or execution problems</td>
<td>No studies available. Conclusion based on usual practice, expert consensus, clinical experience, opinion, or extrapolation from basic research</td>
<td>No evidence that pertains to question being addressed</td>
</tr>
<tr>
<td>Consistency of findings across studies</td>
<td>Finding generally consistent in direction and size of effect or degree of association, and statistical significance with minor exceptions at most</td>
<td>Inconsistency among results of studies with strong design, OR consistency with minor exceptions across studies of weaker design</td>
<td>Unexplained inconsistency among results from different studies OR single study unconfirmed by other studies</td>
<td>Conclusion supported solely by statements of informed nutrition or medical commentators</td>
<td>NA</td>
</tr>
<tr>
<td>Quantity; Number of studies; Number of subjects in studies</td>
<td>One to several good quality studies; Larger numbers of subjects studied; Studies with negative results have sufficiently large sample size for adequate statistical power</td>
<td>Several studies by independent investigators; Doubts about adequacy of sample size to avoid Type I and Type II error</td>
<td>Limited number of studies; Low number of subjects studied and/or inadequate sample size within studies</td>
<td>Unsubstantiated by published research studies</td>
<td>Relevant studies have not been done</td>
</tr>
<tr>
<td>Clinical impact; Importance of studied outcomes; Magnitude of effect</td>
<td>Studied outcome relates directly to the question; Size of effect is clinically meaningful; Significant (statistical) difference is large</td>
<td>Some doubt about the statistical or clinical significance of the effect</td>
<td>Studied outcome is an intermediate outcome or surrogate for the true outcome of interest OR size of effect is small or lacks statistical and/or clinical significance</td>
<td>Objective data unavailable</td>
<td>Indicates area for future research</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Generalizability to population of interest</td>
<td>Studied population, intervention and outcomes are free from serious doubts about generalizability</td>
<td>Minor doubts about generalizability</td>
<td>Serious doubts about generalizability due to narrow or different study population, intervention or outcomes studies</td>
<td>Generalizability limited to scope of experience</td>
<td>NA</td>
</tr>
</tbody>
</table>
### APPENDIX E: EVIDENCE ANALYSIS SUMMARY

Adapted from Ihmels et al., 2007

<table>
<thead>
<tr>
<th>Influence</th>
<th>Conclusion Statement</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity</td>
<td>Participation in regular physical activity is associated with a reduced risk of overweight but the effect appears to be stronger in boys than in girls.</td>
<td>III</td>
</tr>
<tr>
<td>Physical Inactivity (Television Viewing)</td>
<td>There are inconsistent relationships between inactivity and risk for overweight/obesity in the literature but the larger and better controlled studies tend to reveal small but significant associations between these variables</td>
<td>II</td>
</tr>
<tr>
<td>Physical Inactivity (Video Games)</td>
<td>There is evidence in longitudinal studies that frequent use of video games may increase risk of overweight but additional research is needed to confirm the association.</td>
<td>III</td>
</tr>
<tr>
<td>Caloric Intake</td>
<td>Total energy (caloric) intake measured using current dietary assessment tools, which may not accurately assess total energy intake does not appear to have a strong association with overweight in children.</td>
<td>II</td>
</tr>
<tr>
<td>Dietary Fat</td>
<td>Dietary fat appears to be associated with obesity in children; however current dietary assessment methods are limited in their ability to accurately measure nutrient intake. The evidence from these observational studies does not support the notion that low dietary fat intake is associated with childhood obesity</td>
<td>II</td>
</tr>
<tr>
<td>Sweetened Beverages</td>
<td>Evidence suggests that it may be physiologically more difficult to compensate for energy consumed as a liquid than as a solid food, and that consumption of sugar-sweetened beverages results in increased energy intake.</td>
<td>II/III</td>
</tr>
<tr>
<td>100% Fruit Juice</td>
<td>Increased consumption of 100% fruit juice does not appear to be associated with increased overweight in children.</td>
<td>II</td>
</tr>
<tr>
<td>Calcium</td>
<td>A low intake of calcium and dairy products may be associated with overweight in children. However, the mechanism for this relationship has not been firmly established in children (i.e., whether due to a biological effect of lack of calcium or dairy, an avoidance of dairy by overweight children, and/or replacement of fluid milk with soft drinks and other sweetened beverages).</td>
<td>III</td>
</tr>
<tr>
<td>Breakfast Skipping</td>
<td>Breakfast skipping may be associated with increased risk of overweight, particularly among older children and adolescents. However, what constitutes a breakfast has not been systematically defined and longitudinal studies of the relationship between breakfast habits and adiposity are notably lacking.</td>
<td>II</td>
</tr>
<tr>
<td>Parental Restriction of Food</td>
<td>Parental restriction of highly palatable foods promotes children’s desire for such forbidden foods, causing dysregulation of caloric intake and overeating. It appears that this child-feeding practice is associated with overweight in children; however a majority of the research has been conducted among non-Hispanic, white girls and may be applicable only to this population.</td>
<td>II</td>
</tr>
<tr>
<td>Family Functioning</td>
<td>Positive aspects of family functioning such as family cohesion, expressiveness, democratic style, parental support and cognitive stimulation at home may be protective against childhood overweight, while other negative aspects of family functioning such as mother’s lack of interest in her offspring or lack of parental support may be associated with overweight in children.</td>
<td>III</td>
</tr>
</tbody>
</table>
APPENDIX F: FOUR VERSIONS OF THE FNPA

Version 1: Subjective

*Thank you for completing the Family Nutrition & Physical Activity Tool!*

**Instructions:** For each question, select the answer category that best fits your child or your family. It is important to indicate the most common or typical pattern for your family, and not what you would like to happen.

### Family Meals.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/Almost Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often does your child eat breakfast, either at home or at school?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. How often does your child eat at least one meal a day with at least one other family member?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Family Eating Practices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/Almost Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. How often does your child eat while watching TV? [Includes meals or snacks]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. How often does your family eat “fast food?”</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Food Choices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/Almost Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. How often does your family use packaged “ready-to-eat” foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. How often does your child eat fruits and vegetables at meals or snacks? [Not including juice]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
### Beverage Choices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. How often does your child drink soda pop or sweetened beverages?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>[Includes regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, fruit or vegetable juice, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade, etc.]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. How often does your child drink low-fat milk for meals or snacks?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>[Includes 1% or skim dairy, flavored, soy, almond, etc.]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Restriction/Reward.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. How often does your family monitor the amount of candy, chips, and cookies your child eats?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. How often does your family use candy, ice cream or other foods as a reward for good behavior?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Screen Time.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. How often does your child have less than 2 hours of “screen time” in a day? [Includes TV, computer, game system, or any mobile device with visual screens]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. How often does your family monitor the amount of “screen time” your child has?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
### Healthy Environment.

<table>
<thead>
<tr>
<th>13. How often does your child engage in screen time in his/her bedroom?</th>
<th>Never/Almost Never</th>
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</table>

<table>
<thead>
<tr>
<th>14. How often does your family provide opportunities for physical activity?</th>
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</table>

### Family Activity.

<table>
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<tr>
<th>15. How often does your family encourage your child to be physically active?</th>
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<th>16. How often does your child do physical activities with at least one other family member?</th>
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### Child Activity.

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<tr>
<th>17. How often does your child do something physically active when he/she has free time?</th>
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<table>
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<tr>
<th>20. How often does your child get enough sleep at night?</th>
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The FNPA Tool was developed at Iowa State University by Michelle Ihmels (mihmels@iastate.edu) and Greg Welk (gwelk@iastate.edu) in partnership with the American Dietetics Association.
Version 2: Subjective with Recommended Practices

Thank you for completing the Family Nutrition & Physical Activity Tool!

Instructions: For each question, select the answer category that best fits your child or your family. It is important to indicate the most common or typical pattern for your family, and not what you would like to happen.

Family Meals (Recommended Practice): Children who regularly skip breakfast show an increased risk of becoming overweight, particularly among older children and adolescents. Eating meals together as a family helps to encourage positive family interactions related to eating.

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<tr>
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<th>Very Often/Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often does your child eat breakfast, either at home or at school?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. How often does your child eat at least one meal a day with at least one other family member?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Family Eating Practices (Recommended Practice): Regularly eating food away from home, particularly at fast food establishments, has been associated with increased risk for overweight, especially among adolescents. It is harder to make healthier choices when eating out, so reducing meals out can promote healthier eating. Also, watching television while eating meals can cause children to eat too much or to eat less healthy foods.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/A</th>
<th>Sometimes</th>
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<th>Very Often/Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. How often does your child eat while watching TV? [Includes meals or snacks]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. How often does your family eat “fast food?”</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Food Choices (Recommended Practice): Prepackaged foods generally contain more fat and salt than freshly prepared meals, and dietary fat intake is associated with higher overweight levels in youth. Eating more fruits and vegetables reduces a child’s risk for being overweight.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>5. How often does your family use packaged “ready-to-eat” foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. How often does your child eat fruits and vegetables at meals or snacks? [Not including juice]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**Beverage Choices (Recommended Practice):** Drinking sugar-sweetened beverages is related to an increased risk of children becoming overweight. Studies also suggest that a child with a low intake of calcium may be at increased risk for becoming overweight.

<table>
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<tr>
<th>Question</th>
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<th>Very Often / Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. How often does your child drink soda pop or sweetened beverages?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>[Includes regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, fruit or vegetable juice, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade, etc.]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. How often does your child drink low-fat milk for meals or snacks?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>[Includes 1% or skim dairy, flavored, soy, almond, etc.]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Restriction/Reward (Recommended Practice):** Forbidding items such as snack food and candy can actually increase a child’s desire for those foods. Allowing them on a limited basis lets children learn to regulate their behavior. Using these kinds of foods as rewards can cause children to value them over other healthier options.

<table>
<thead>
<tr>
<th>Question</th>
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</thead>
<tbody>
<tr>
<td>9. How often does your family monitor the amount of candy, chips, and cookies your child eats?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. How often does your family use candy, ice cream or other foods as a reward for good behavior?</td>
<td>1</td>
<td>2</td>
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<td>4</td>
</tr>
</tbody>
</table>

**Screen Time (Recommended Practice):** Excessive television viewing and video game use is associated with increased overweight in youth. Current recommendations are that children should have 2 hours or less of screen time (television, video games, and computer time) per day.

<table>
<thead>
<tr>
<th>Question</th>
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</tr>
</thead>
<tbody>
<tr>
<td>11. How often does your child have less than 2 hours of “screen time” in a day? [Includes TV, computer, game system, or any mobile device with visual screens]</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. How often does your family monitor the amount of “screen time” your child has?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**Healthy Environment (Recommended Practice):** Creating a healthy environment is important for encouraging physical activity. Removing televisions and other screen devices from bedrooms helps to reduce the likelihood of excess use. Provide opportunities to be active.

<table>
<thead>
<tr>
<th></th>
<th>Never/April Never</th>
<th>Sometimes</th>
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</tr>
</thead>
<tbody>
<tr>
<td>13. How often does your child engage in screen time in his/her bedroom?</td>
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<td>4</td>
</tr>
<tr>
<td>14. How often does your family provide opportunities for physical activity?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Family Activity (Recommended Practice):** Children sometimes need to be reminded or encouraged to be physically active. Parents are important role models for their children. By being active as a family you can help establish healthy lifestyle practices that promote and reinforce physical activity as a family value.

<table>
<thead>
<tr>
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<td>16. How often does your child do physical activities with at least one other family member?</td>
<td>1</td>
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<td>4</td>
</tr>
</tbody>
</table>

**Child Activity (Recommended Practice):** A child’s participation in regular physical activity is associated with a reduced risk of becoming overweight. Parents can plan activity into their day but kids may need reminders or specific opportunities to help them be active every day.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>17. How often does your child do something physically active when he/she has free time?</td>
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<tr>
<td>18. How often does your child participate in organized sports or physical activities with a coach or leader?</td>
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</table>

**Family Schedule/Sleep Routine (Recommended Practice):** Most children respond best to a daily routine or schedule for bedtime. Research suggests that lack of sleep and irregular routines may increase a child’s risk for becoming overweight.

<table>
<thead>
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<td>19. How often does your child follow a regular routine for your child’s bedtime?</td>
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**Version 3: Objective**

*Thank you for completing the Family Nutrition & Physical Activity Tool!*

**Instructions:** For each question, select the answer category that best fits your child or your family. It is important to indicate the most common or typical pattern for your family, and not what you would like to happen.

### Family Meals.

<table>
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<th></th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In a typical week, how many days does your child eat breakfast, either at home or at school?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. In a typical week, how many days does your child eat at least one meal with another family member?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tbody>
</table>

### Family Eating Practices.

<table>
<thead>
<tr>
<th></th>
<th>0 days</th>
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</tr>
</thead>
<tbody>
<tr>
<td>3. In a typical week, how many days does your child eat while watching TV? [Includes meals or snacks]</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>4. In a typical week, how many days does your family eat “fast food?”</td>
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</tbody>
</table>

### Food Choices.

<table>
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<tr>
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<tbody>
<tr>
<td>5. In a typical week, how many days does your family use packaged “ready-to-eat” foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</td>
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<td>3</td>
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<td>6. In a typical week, how many days does your child eat fruits and vegetables at meals or snacks? [Not including juice]</td>
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### Beverage Choices.

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<tr>
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<tr>
<td>7. In a typical week, how many days does your child drink soda pop or sweetened beverages? [Includes regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, fruit or vegetable juice, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade, etc.]</td>
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<td>8. In a typical week, how many days does your child drink low-fat milk for meals or snacks? [Includes 1% or skim dairy, flavored, soy, almond, etc.]</td>
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### Restriction/Reward.

<table>
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<td>a reward for good behavior?</td>
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### Screen Time.

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<tr>
<td>your child has?</td>
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</table>

### Healthy Environment.

<table>
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</tr>
<tr>
<td>activity?</td>
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### Family Activity.

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</tr>
<tr>
<td>active?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. How often does your child do physical activities with at least one</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
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### Child Activity.

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<tbody>
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<td>17. How often does your child do something physically active when he/</td>
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<td>2</td>
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<td>4</td>
</tr>
<tr>
<td>she has free time?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. How often does your child participate in organized sports or</td>
<td>1</td>
<td>2</td>
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<td>4</td>
</tr>
<tr>
<td>physical activities with a coach or leader?</td>
<td></td>
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</table>
### Family Schedule/Sleep Routine.

<table>
<thead>
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<tbody>
<tr>
<td>19. How often does your child follow a regular routine for your child’s bedtime?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20. How many hours does your child usually sleep in a 24-hour period?</td>
<td>Less than 8 hours</td>
<td>8 to 10 hours</td>
<td>10 to 12 hours</td>
<td>More than 12 hours</td>
</tr>
<tr>
<td></td>
<td>1</td>
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**Version 4: Objective with Recommended Practices**

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**Instructions:** For each question, select the answer category that best fits your child or your family. It is important to indicate the most common or typical pattern for your family, and not what you would like to happen.

**Family Meals (Recommended Practice):** *Children who regularly skip breakfast show an increased risk of becoming overweight, particularly among older children and adolescents. Eating meals together as a family helps to encourage positive family interactions related to eating.*

<table>
<thead>
<tr>
<th>1. In a typical week, how many days does your child eat breakfast, either at home or at school?</th>
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</table>

<table>
<thead>
<tr>
<th>2. In a typical week, how many days does your child eat at least one meal with at least one other family member?</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Family Eating Practices (Recommended Practice):** *Regularly eating food away from home, particularly at fast food establishments, has been associated with increased risk for overweight, especially among adolescents. It is harder to make healthier choices when eating out, so reducing meals out can promote healthier eating. Also, watching television while eating meals can cause children to eat too much or to eat less healthy foods.*

<table>
<thead>
<tr>
<th>3. In a typical week, how many days does your child eat while watching TV? [Includes meals or snacks]</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. In a typical week, how many days does your family eat “fast food?”</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Food Choices (Recommended Practice):** *Prepackaged foods generally contain more fat and salt than freshly prepared meals, and dietary fat intake is associated with higher overweight levels in youth. Eating more fruits and vegetables reduces a child’s risk for overweight. The effect may be direct or indirect (by reducing consumption of other foods).*

<table>
<thead>
<tr>
<th>5. In a typical week, how many days does your family use packaged “ready-to-eat” foods? [Includes purchased frozen or on-the-shelf entrees, often designed to be microwaved]</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. In a typical week, how many days does your child eat fruits and vegetables at meals or snacks? [Not including juice]</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**Beverage Choices (Recommended Practice):** Drinking sugar-sweetened beverages is related to an increased risk of children becoming overweight. Studies also suggest that a child with a low intake of calcium may be at increased risk for becoming overweight.

<table>
<thead>
<tr>
<th>7. In a typical week, how many days does your child drink soda pop or sweetened beverages? [Includes regular or diet soda pop, Kool-Aid, Sunny-D, Capri Sun, fruit or vegetable juice, caffeinated energy drinks (Monster/Red Bull), Powerade/Gatorade, etc.]</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. In a typical week, how many days does your child drink low-fat milk for meals or snacks? [Includes 1% or skim dairy, flavored, soy, almond, etc.]</th>
<th>0 days</th>
<th>1 or 2 days</th>
<th>3 to 5 days</th>
<th>6 or 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Restriction/Reward (Recommended Practice):** Forbidding items such as snack food and candy can actually increase a child’s desire for those foods. Allowing them on a limited basis lets children learn to regulate their behavior. Using these kinds of foods as rewards can cause children to value them over other healthier options.

<table>
<thead>
<tr>
<th>9. How often does your family monitor the amount of candy, chips, and cookies your child eats?</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. How often does your family use candy, ice cream or other foods as a reward for good behavior?</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Screen Time (Recommended Practice):** Excessive television viewing and video game use is associated with increased overweight in youth. Current recommendations are that children should have 2 hours or less of screen time (television, video games, and computer time) per day.

<table>
<thead>
<tr>
<th>11. How often does your child have less than 2 hours of “screen time” in a day? [Includes TV, computer, game system, or any mobile device with visual screens]</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. How often does your family monitor the amount of “screen time” your child has?</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**Healthy Environment (Recommended Practice):** Creating a healthy environment is important for encouraging physical activity. Removing televisions and other screen devices from bedrooms helps to reduce the likelihood of excess use. Provide opportunities to be active.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. How often does your child engage in screen time in his/her bedroom?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. How often does your family provide opportunities for physical activity?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Family Activity (Recommended Practice):** Children sometimes need to be reminded or encouraged to be physically active. Parents are important role models for their children. By being active as a family you can help establish healthy lifestyle practices that promote and reinforce physical activity as a family value.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. How often does your family encourage your child to be physically active?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. How often does your child do physical activities with at least one other family member?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Child Activity (Recommended Practice):** A child’s participation in regular physical activity is associated with a reduced risk of becoming overweight. Parents can plan activity into their day but kids may need reminders or specific opportunities to help them be active every day.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. How often does your child do something physically active when he/she has free time?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. How often does your child participate in organized sports or physical activities with a coach or leader?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Family Schedule/Sleep Routine (Recommended Practice):** Most children respond best to a daily routine or schedule for bedtime. Research suggests that lack of sleep and irregular routines may increase a child’s risk for becoming overweight.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/April Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always/April Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. How often does your child follow a regular routine for your child’s bedtime?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Less than 8 hours</th>
<th>8 to 10 hours</th>
<th>10 to 12 hours</th>
<th>More than 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. How many hours does your child usually sleep in a 24-hour period?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
APPENDIX G. DEMOGRAPHIC SURVEY FOR STUDY 2 AND STUDY 3

Please provide some information about your background. This information will be used to summarize the research participants. Your individual information will not be disclosed.

1. Please enter your child's Des Moines School District student ID, provided on the letter you received from the research team. __________________________

2. Your Child’s School Building: ________________________________

3. Your Age:
   - Under 25 years
   - 25 to 29 years
   - 30 to 39 years
   - 40 to 49 years
   - 50 or older

4. Your Gender:
   - Male
   - Female

5. Your Race/Ethnicity:
   - White/Caucasian
   - Black/African American
   - Hispanic/Latino
   - Asian
   - American Indian/Alaskan Native/Native Hawaiian/Pacific Islander
   - Other
6. Your family’s annual income from all sources:
   - Less than $20,000
   - $20,000 up to $40,000
   - $40,000 up to $70,000
   - $70,000 up to $100,000
   - $100,000 or more

7. Highest level of school you have completed:
   - Less than high school graduate
   - High school graduate or GED
   - Some college but no degree
   - Associate (2-year) degree or Technical/Vocational training
   - Bachelor’s degree
   - Master’s degree, Professional degree, Doctorate

8. What is the mother’s approximate height? ___ft ___in

9. What is the mother’s approximate weight? ____lbs

10. What is the father’s approximate height? ___ft ___in

11. What is the father’s approximate weight? ____lbs

If you are willing to be contacted with information about future research studies or to be notified when the results of this study are available, please provide your email address here:

E-mail Address: ____________________________
APPENDIX H. MODIFIED USDA US FOOD SECURITY SURVEY MODULE

Part 1
1. Which of these statements best describes the food eaten in your household in the last 12 months:
   
   o Enough of the kinds of food we want to eat
   o Enough but not always the kinds of food we want
   o Sometimes not enough to eat
   o Often not enough to eat

For the following statements, please indicate whether the statement was often true, sometimes true, or never true for your household in the last 12 months:

2. We worried whether our food would run out before we got money to buy more.
   o Often true
   o Sometimes true
   o Never true

3. The food that we bought just didn’t last and we didn’t have money to get more.
   o Often true
   o Sometimes true
   o Never true

4. We couldn’t afford to eat balanced meals.
   o Often true
   o Sometimes true
   o Never true

Part 2
1. In the last 12 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn’t enough money for food?
   o Yes
   o No (Skip 1a)

1a. If YES above, how often did this happen?
   o Almost every month
   o Some months but not every month
   o Only 1 or 2 months
2. In the last 12 months, did you ever eat less than you felt you should because there wasn’t enough money for food?
   - Yes
   - No

3. In the last 12 months, were you ever hungry but didn’t eat because there wasn’t enough money for food?
   - Yes
   - No

4. In the last 12 months, did you lose weight because there wasn’t enough money for food?
   - Yes
   - No

5. In the last 12 months, did you or other adults in your household ever not eat for a whole day because there wasn’t enough money for food?
   - Yes
   - No (Skip 5a)

5a. If YES above, how often did this happen?
   - Almost every month
   - Some months but not every month
   - Only 1 or 2 months

Part 3
For the following statements, please indicate whether the statement was often true, sometimes true or never true in the last 12 months for your child/children living in the household who are under 18 years old.

1. We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food.
   - Often true
   - Sometimes true
   - Never true

2. We couldn’t feed the children a balanced meal, because we couldn’t afford that.
   - Often true
   - Sometimes true
   - Never true
3. The children were not eating enough because we just couldn’t afford enough food.
   - Often true
   - Sometimes true
   - Never true

4. In the last 12 months, did you ever cut the size of any child’s meals because there wasn’t enough money for food?
   - Yes
   - No

5. In the last 12 months, did any child ever skip meals because there wasn’t enough money for food?
   - Yes
   - No (Skip 5a)

5a. If YES above, how often did this happen?
   - Almost every month
   - Some months but not every month
   - Only 1 or 2 months

6. In the last 12 months, was your child ever hungry but you just couldn’t afford more food?
   - Yes
   - No

7. In the last 12 months, did your child ever not eat for a whole day because there wasn’t enough money for food?
   - Yes
   - No