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# A Longitudinal Examination of the Influences of Family Processes and Demographic Variables on Adolescent Weight

Jessica Lee Price

*Brigham Young University - Provo*

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A LONGITUDINAL EXAMINATION OF THE INFLUENCES OF  
FAMILY PROCESSES AND DEMOGRAPHIC VARIABLES  
ON ADOLESCENT WEIGHT

by

Jessica L. Smith Price

A thesis submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirements for the degree of

Master of Science

School of Family Life

Brigham Young University

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BRIGHAM YOUNG UNIVERSITY

GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

Jessica L. Smith Price

This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Randal D. Day, Chair

\_\_\_\_\_  
Date

\_\_\_\_\_  
Laura Padilla Walker

\_\_\_\_\_  
Date

\_\_\_\_\_  
Jeremy B. Yorgason

BRIGHAM YOUNG UNIVERSITY

As chair of the candidate's graduate committee, I have read the thesis of Jessica L. Smith Price in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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Date

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Randal D. Day  
Chair, Graduate Committee

Accepted for the Department

---

Dean M. Busby  
Graduate Coordinator

Accepted for the College

---

Elaine Walton  
Associate Dean, College of Family, Home and  
Social Science

## ABSTRACT

### A LONGITUDINAL EXAMINATION OF THE INFLUENCES OF FAMILY PROCESSES AND DEMOGRAPHIC VARIABLES ON ADOLESCENT WEIGHT

Jessica L. Smith Price

School of Family Life

Master of Science

Nationally representative studies estimate that almost one in five adolescents in the United States is overweight. This is a major concern for individuals' physical and psychological health and the overall economy in terms of health care costs and loss of productivity. The approach of this study was to understand adolescent overweight as influenced by family processes including: parent-adolescent relationship, monitoring or parental knowledge, control, family meals, and parenting styles. Race, sex, family structure, income, and mother Body Mass Index (BMI) were also included.

A sub-sample of 4,688 adolescents from the National Longitudinal Survey of Youth 1997 was used to address the association between family processes, demographic variables, and adolescent Body Mass Index (BMI) percentile over four years. Due to the inclusion of siblings in the sample, the data are non-independent. Longitudinal multilevel

modeling was used to adjust for this non-independence. The final model indicated that frequency of family meals, sex, race, father's parenting style, control, and mother's BMI were important predictors of adolescent BMI percentile over time. Mother's BMI was the strongest predictor of adolescent BMI percentile. More frequent family meals led to decreases in BMI percentile over time, while males, African Americans, and Latinos had higher average BMI percentiles than other groups.

These findings suggest the need for intervention that focuses on mother's health and healthy behaviors in the home. At risk groups, including African American and Latino adolescents and males, should be targeted for these interventions. Additionally, the results indicated that using multilevel modeling with the NLSY97 was important due to nesting within families.

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## Chapter I

### Introduction

Nationally representative studies estimate that almost one in five adolescents in the United States is overweight (USDHHS, 2004). Analysis of previous studies indicate that adolescent rates of overweight were stable throughout the 1960s-1980s, but began to rapidly accelerate from the late 1980s to the present (USDHHS, 1980; USDHHS, 2004). From 1988 to 2004 the rate of adolescent overweight increased from eleven percent to seventeen percent. Recent studies do not indicate a slowing or leveling of the trend, but rather a continued increase in the percentage of overweight adolescents in America (USDHHS, 2004). This problem is of major concern for physical and psychological health (Ackard, Neumark-Sztainer, Story, & Perry, 2003; Freedman, Dietz, Srinivasan, Berenson, 1999) and the overall economy in terms of health care costs and loss of productivity (USDHHS, 2001).

Researchers from diverse fields have suggested that the etiology of overweight is multifactorial. Although being overweight is nearly always a result of an energy (calorie) imbalance (Marti & Martinez, 2006), emerging reasons for this imbalance include interactions between many variables such as poverty and food availability (Ball, Crawford, & Mishra, 2006; Videon & Manning, 2003), community design (USDHHS, 2001), food marketing and advertising (Lobstein & Dobb, 2005), and family processes (Arredondo et al., 2006; Neumark-Sztainer, Story, Ireland, Resnick, 2002; Ogden, Reynolds, & Smith, 2006). The current study focuses on the contribution of family processes and adolescent overweight by examining the effects of multiple family

processes on adolescent BMI percentile over and above the effect of mother's BMI and demographic variables.

### *Theoretical Orientation*

Family process theory provides the theoretical foundation for the current study. A family process theory orientation assumes that families are goal-seeking entities (Broderick, 1993; Day, Gavazzi, & Acock, 2001). Families operate as systems that use family processes to pursue goals. Family processes include the interactions, strategies, and relationships between individuals in the family, across boundaries, and within and outside of the family system (Day, Gavazzi, & Acock, 2001). By utilizing this perspective, the association between family processes and adolescent overweight can be explored. This viewpoint assumes that families, in the way they interact and implement strategies, can influence adolescent overweight beyond genetic explanations.

Although studies of family behavior, food, and overweight have used family processes constructs, they have not explicitly used or addressed a family process theory orientation. The current study seeks to theoretically move forward the discussion of the association between family processes and adolescent weight. Fundamental principles of family process theory include the idea that families both create ideologies--or ways of interpreting and interacting with the world--and strategies to achieve goals. While ideologies and strategies are typically hidden from view, they can influence an individual family member's ability to flourish (Day, Gavazzi, Miller, & Van Langeveldt, 2006). One way to conceptualize family processes is to describe the multiple domains of inner family life and what family members do with one another: including, regulating, connecting, nurturing, protecting, and provisioning (Day, Gavazzi, Miller, & Van Langeveldt, 2007).

The primary goal of this study is to better understand adolescent overweight as influenced by how family members interact with one another within these domains. For example, ideologies and strategies related to parenting may also extend to strategies related to food, exercise, and other health behaviors. The ideologies and strategies may be enacted in domains such as regulating (how much control do parents exercise over food choices?) or connecting (do family meals provide a positive experience with family members and food?).

Specifically, the purpose of this study is to examine how family processes (e.g. parental monitoring, parental control, parent-child relationships, family dinners, and parenting style) and demographic variables, are associated with adolescent overweight over time in a large diverse sample. It is anticipated that family processes will significantly affect adolescent weight status over time. In particular, it is hypothesized that positive family processes such as appropriate monitoring and control, supportive parent-child relationships, frequent family dinners, and authoritative parenting will be associated with a healthier weight and weight maintenance. Conversely, negative family processes, such as high control and authoritarian, permissive, or uninvolved parenting, are hypothesized to be associated with unhealthy changes in adolescent weight over time.

### *Causes of Overweight*

Current rates of adolescent overweight are startling. The Healthy People 2010 initiative set goals for the distribution of youth body mass index (BMI) in the population; although the goal is to have only five percent of adolescents over the 95<sup>th</sup> BMI percentile, in 2002 12.5 percent of girls and 16.6 percent of boys were over the 95<sup>th</sup> percentile for height and weight (Neumark-Sztainer, Story, Hannon, & Croll, 2002). We know that

overweight and obesity are influenced by genetics. However, most research suggests that a primary cause of overweight is an imbalance between energy consumed and energy expended (Marti & Martinez, 2006; Mutch & Clement, 2006).

There is strong evidence to support a connection between dietary practices in adolescents and body mass index (BMI) percentiles (Decaluwe, Bracet, & Fairburn, 2003). Raw BMI scores are calculated as a ratio of weight to height. For adults, raw BMI scores can be used to effectively estimate an individual's weight status (CDC, 2007). However, because of greater variability in children and adolescents by age and sex, children's and adolescent's BMI is calculated using a percentile. Although inappropriate for diagnostic uses and not accurate for all individuals, the BMI percentile is a fairly reliable measure of fatness and potential risk (Mei et al., 2002). Body mass index percentiles are assigned based on the youth's height, weight, age in months, and sex by the Centers for Disease Control (2000). Healthy children can range from the 5<sup>th</sup> percentile to the 85<sup>th</sup> percentile, with children from the 85<sup>th</sup> to 95<sup>th</sup> percentile classified as "at risk for overweight" (corresponding to the adult "overweight" category) and with children over the 95<sup>th</sup> percentile classified as "overweight" (corresponding to the adult "obese" category) (CDC, 2000).

Increased portion size and high calorie content are associated with higher in BMI percentile for teens (Huang, Howarth, Lin, Roberts, & McCrory, 2004). Conversely, teens who choose a diet high in fruits, vegetables, and whole grains and low in fat have lower BMI percentiles (Jequier & Gray, 2002; Astrup, 2006), but these diet characteristics are becoming less common (Neumark-Sztainer, Sotry, Hannon, & Croll, 2002; Videon & Manning, 2003). These healthful foods are increasingly being replaced

by high fat and high sugar foods that contribute to overweight (Davison & Birch, 2001). Worldwide, but particularly in the U.S., children's soda consumption has risen dramatically, as well as the inclusion of fast food and other foods prepared away from home in their diets (Adair & Popkin, 2005). Diets including these high fat and high calorie foods have been linked directly to higher BMI percentiles in adolescents (Davison & Birch, 2001).

As rates of childhood obesity have continued to rise, descriptive studies have found changing and alarming patterns in children's eating habits and physical activity (Neumark-Sztainer, Story, Hannon, & Croll, 2002; Videon & Manning, 2003). National estimates of adolescent diet patterns suggest that approximately half of adolescents in the United States do not consume the recommended levels of fruits or dairy products, and that 71 percent do not eat the recommended amount of vegetables (Videon & Manning, 2003). In the same national survey, about twenty percent of adolescents in the sample skipped breakfast the day before the survey was administered (Videon & Manning, 2003). Skipping breakfast can lead to increased eating throughout the day and is another indicator of an unhealthy diet (Berky, Rockett, Gillman, Field, & Colditz, 2003). Another study found that many adolescents' diets are higher in fat and lower in fruits, vegetables, grains, and calcium than recommended (Neumark-Sztainer, Story, Hannon, & Croll, 2002).

For minority children and adolescents the picture is even bleaker: African American children, on average, have lower levels of dairy consumption and eat higher amounts of food high in fat and sugars than Caucasian children (Videon & Manning,

2003). There are also marked gender differences; girls are more likely to consume fruits and vegetables and less likely to consume protein than boys (Videon & Manning, 2003).

In addition to diet, physical activity is an important part of predicting, preventing, and treating overweight. According to the United States Department of Health and Human Services *Healthy Youth Report* (2006), youth in America are increasingly and dangerously sedentary. Among high school students, 35 percent do not engage in vigorous physical activity on a regular basis (USDHHS, 2006). The report outlined the critical role of physical activity in achieving and maintaining a healthy weight, and attributed part of the increasing rates of childhood overweight to this sedentary lifestyle (USDHHS, 2006). Regular physical activity has been associated with lower body mass indexes in other studies as well (Ara, Jimenez-Ramirez, Dorado, Serrano-Sanchez, & Calbet, 2004; Hanson & Chen, 2007), and its powerful effects have been shown to even mediate the association between SES and race on body mass index (Hanson & Chen, 2007). With regard to physical activity and child BMI, there are especially concerning findings regarding already overweight children and exercise. Children, especially boys, who are already overweight are less active than their non-overweight peers. This inactivity potentially compounds an already challenging situation (Sirard, Dowda, Pfeiffer, & Pate, 2003).

### *Consequences of Overweight*

The lifestyle characteristics discussed above are linked to child and adolescent overweight (Davison & Birch, 2001). Children and adolescents with overweight experience lower quality of life in social, physical, and academic domains (Pinhas-Hamiel et al., 2006; Willimas, Wake, Hesketh, Maher, & Waters, 2005). While moderate

levels of overweight do not predict serious effects in these important aspects of life, but being severely overweight as a child leads to poorer outcomes in a variety of areas including physical health, peer relationships, and psychological outcomes (Pinhas-Hamiel et al., 2006). Abundant evidence in the medical literature supports the importance of the maintenance or achievement of normal weight ranges in childhood (Pinhas-Hamiel et al., 2006; Ramchandani, 2004; Thompson et al., 2007). This is because being overweight is associated with higher diastolic blood pressure, higher levels of LDL cholesterol, abnormal fasting insulin concentration, and lower cardiovascular fitness levels. When overweight or obese individuals lose weight, even in modest amounts, benefits include decreased cholesterol levels and lower blood pressure (Zeller, Claytor, Satangelo, Khourey, & Daniels, 2005).

Overweight, even in childhood, increases risk of Type 2 diabetes, hypertension, heart disease, stroke, sleep apnea, asthma, and degenerative joint disease (for review see O'Brien & Dixon, 2002; Ramchandani, 2004; Thompson et al., 2007). Overweight individuals report significantly lower quality of life, and frequently experience health complications that can lead to premature death (O'Brien & Dixon, 2002). These health consequences for overweight persons frequently appear during childhood, and are similar to those experienced by adults. The stability of overweight status into adulthood makes these findings particularly alarming (Guo, Wu, Chulea, & Roche, 2002).

If childhood overweight is not adequately treated, the BMI is generally stable though adolescence and adulthood (Brambilla et al., 1999; Sandhu, Ben-Schlomo, Cole, Holly, & Davey-Smith, 2005). There is strong evidence that overweight in childhood is associated with persistent overweight both in adolescence (Sandhu, Ben-Schlomo, Cole,

Holly, & Davey-Smith, 2005) and adulthood (Guo, Wu, Chulea, & Roche, 2002). In a study of the effect of early childhood overweight on adolescent obesity, early childhood BMI was a stronger predictor of adolescent overweight than was parent BMI (Salbe et al., 2002). There is additional evidence to suggest that overweight is not only stable through adolescence, but for many increases through that time and into adulthood. In a sample of African American and Caucasian girls, rates of overweight from childhood to adolescence increased from seven percent to ten percent for Caucasian girls and from seventeen percent to twenty-four percent in African American girls (Thompson et al., 2007). Because of the stability of the condition and gravity of its effects, prevention and treatment in childhood are critical (Brambilla et al., 1999).

In addition to the health consequences of overweight and obesity, children with overweight frequently experience negative psychological outcomes including depression, suicide, body dissatisfaction, and low self-esteem (Ackard, Neumark-Sztainer, Story, & Perry, 2003). In addition to these psychological outcomes, negative social outcomes are also more common for this group. Overweight children are more likely to be teased about appearance than non-overweight peers, and are more likely to report feelings of loneliness, poorer self perception, and increased sedentary activity (Hayden-Wade et al., 2005).

The social and psychological effects may last into adulthood. A longitudinal study that followed adolescents into young adulthood found that overweight women, on average, completed fewer years of school, were less likely to have married, and had lower incomes than normal weight women. Overweight men were less likely to have married, but did not experience the other negative effects reported by the overweight

women. Interestingly, these effects were not common among people in the sample with other chronic health conditions (besides obesity) (Gortmaker, Must, Perrin, & Sobol, 1993). These findings suggest that overweight women are at a greater social disadvantage than overweight men, and that obesity functions psychosocially in different ways than other health conditions. This may be attributed to the greater social stigma associated with overweight and obesity (Carr, 2005; Shapiro, King, Quinones, 2007) particularly for women (Price & Pecjak, 2003).

Research indicates that family processes are influential predictors both for overweight and for the health-related behaviors that can lead to childhood overweight. For example, children who experience more positive family interactions eat breakfast, vegetables, and fruits more frequently than children from families with low connectedness (Neumark-Sztainer, Story, Ireland, Resnick, 2002). Additional support for a family process approach to childhood obesity stems from Sweeting's (2005) finding that family structure is not related to an unhealthy diet, however, other evidence suggests that unhealthy eating can be attributed to family processes such as control (Ogden, Reynolds, & Smith, 2006) and parenting styles (Arredondo et al., 2006) when these processes affect how parents and children interact in relation to food and eating.

## Chapter II

### Review of Literature

#### *Family Processes and Childhood and Adolescent Overweight*

Studies within the medical and family science fields suggest that family processes play a role in the etiology of childhood overweight (Mannix, Faga, & McDonald, 2005; McCurley, Wing, Valoski, 1990). These studies indicate that family processes and adolescent BMI are connected. Most, however, focus on very specific measures of food-related family processes. In the current study, non-food specific measures are used to determine how global family processes influence adolescent weight in ways similar to food-related family processes. Frequency of family meals will be the only food-related measure in this study. Additionally, this study expands our current knowledge of family processes and adolescent weight by examining a model that includes multiple family processes and demographic variables in order to explore the relative impact of these domains.

Researchers have presented strong evidence that family influences play an important role in becoming overweight. These findings indicate both a heritability of overweight and a family process influence that exist in an interactional relationship. Obese parents are more likely to provide a diet high in fat for their children. Additionally, they permit more television viewing, a sedentary activity, than parents who are not overweight (Krahnstoever, Francis, Birch, 2005). Parents may also model eating behaviors for their children; in one study of a weight loss intervention for middle-childhood girls, change in BMI was most strongly predicted by mothers' BMI change, fathers' caloric intake, and fathers' enjoyment of physical activity (Davison & Birch,

2001). In like manner, children report their parents as their main source for nutritional information, making parents' knowledge and choices influential on children's eating patterns (McCullough, Yoo, Ainsworth, 2004). Taken together, it is clear that a variety of family interactions and behaviors can directly influence overweight in children.

Physical activity, in addition to diet, is an important element of understanding childhood obesity. Sallis et al. (2006) discovered that parental influence was a significant predictor of children's physical activity but the results are varied and sometimes contradictory. In some studies parents' personal attributes were not associated with children's physical activity, while in other studies their own behaviors, their own BMI, and their prompts for the child to exercise were significantly associated with children's physical activity. Although there is disagreement in how personal parental attributes influence child physical activity, there is support for the idea that family process are connected to physical activity. For example, children from families typified by healthy family rules and strong family support report higher levels of physical activity than children from families with family rules that do not promote a healthy lifestyle or provide support for healthy activities (Potvin & Paradis, 2004).

Such family-related findings lead to questions regarding the genetic nature of obesity and whether family process variables are spurious indicators of genetic heritability. There is, generally, overwhelming agreement in the medical community that genetics are an influential but not univariate cause of overweight (see Marti & Martinez, 2006; Mutch & Clement, 2006 for review). In a comprehensive review by Mutch and Clement (2006), overweight and obesity were most commonly the result of an interaction between a genetic susceptibility to weight gain and an environment that has permissive

energy intake and energy exertion. Although some rare cases of overweight or obesity are primarily caused by genetics, most frequently it is caused by a gene-environment interaction over time (Mutch & Clement, 2006). Therefore, family processes and the behaviors they promote can be influential variables because they are a critical part of a child's environment. Certainly, genetics are responsible for wide variation in weight gain in the population, but the source of overweight is a positive energy balance resulting from taking in more energy than is needed (for review see Marti & Martinez, 2006; Speakman, 2004). This variation is influenced by genetics, but in almost all cases exposure to environmental risk, perhaps something such as negative family processes, is necessary to cause overweight or obesity (Marti & Martinez, 2006). There is evidence to suggest that family processes act as sources of environmental risk or protection and are associated with dietary habits, physical activity, and ultimately body mass index (Arredondo et al., 2006; Neumark-Sztainer, Story, Ireland, & Resnick, 2002; Ogden, Reynolds, & Smith, 2006). Several specific family processes have been studied as they relate to food, and the current study will examine similar family processes as they relate to global relationship quality and parenting. These family processes include parenting style, relationship quality, monitoring, control, and family meals.

### *Parenting Styles*

Mothers' and fathers' strategies and approaches to parenting can influence health behaviors and outcomes of children and adolescents (Moens, Ghent, Braet, & Soetens, 2007). Typically, parenting style is measured as a combination of parental supportiveness and demandingness, with an authoritative style (high in supportiveness and high in reasonable demindingness) associated with better developmental outcomes for children

and adolescents (Steinberg, Mounts, Lamborn, & Dornbusch, 1991; Steinberg, Lamborn, Dornbusch, & Darling, 1992). Literature on youth overweight has also found that healthful outcomes are more common in youth with authoritative parents (Moens, Ghent, Braet, & Soetens, 2007). Permissive and authoritarian parenting are most frequently seen in parents of overweight children, while authoritative parenting is observed less frequently (Moens, Ghent, Braet, & Soetens, 2007). Similar effects can be found in the intervention literature. This literature suggests that higher levels of parental acceptance can result in weight loss in children over time. In a sample of adult women, those with binge-eating disorder--often concurrent with or predating overweight (Decaluwe, Bracet, & Fairburn, 2003)--experienced higher parental demandingness as children and youth (Fairburn, Wilfley, Pike, Dohm, & Kraemer, 2005).

In addition to overall weight status, parenting style plays an important role in the health behaviors of children and adolescents. Authoritative styles, including appropriate discipline and support, are associated with children eating unhealthy foods less frequently and participating in physical activity more frequently (Arredondo et al., 2006). Children with authoritative mothers also have higher fruit and vegetable consumption (Kremers, Brug, de Vries, & Engles, 2003; Lytle et al., 2003). Children, particularly girls, with authoritarian parents eat unhealthy foods more frequently and get less exercise (Arredondo et al., 2006). Interestingly, one study found that father authoritarian strategies, but not mother, were associated with higher fruit and vegetable consumption. The authors attributed this finding to the typically less frequent influence fathers have on food choices, therefore making authoritarian strategies more powerful in producing change than they would be for mothers are more frequently involved in meal-time

interaction (Fairburn, Wilfley, Pike, Dohm, Kraemer, 2005). This finding suggests that an authoritarian strategy may be effective if used only occasionally.

### *Relationship Quality*

In addition to the association between parenting style and adolescent overweight, the quality of the parent adolescent relationship also contributes to an adolescent's health choices and overall weight status. The relationship between parents and their children plays an important role in understanding overweight and in treating it. Parent support and involvement increases weight loss during intervention (Kitzmann & Beech, 2006), and although positive parent involvement does not differ overall between overweight and normal weight children, during mealtimes parents are less supportive of children with overweight (Moens, Ghent, Braet, Soetens, 2007). Parent-child relationships typified by caring lead to lower levels of overweight in children, while overprotective father-daughter relationships increase levels of overweight in girls (Turner, Rose, & Cooper, 2005). This indicates that parental care must be appropriately balanced to encourage positive outcomes. Additionally, parent-child relationships characterized by emotional deprivation and abandonment increase the risk of overweight in girls (Turner, Rose, & Cooper, 2005). These effects appear to continue into adulthood: in one study, adult women with binge-eating disorder frequently had conflictual relationships with their parents as children and youth (Fairburn, Wilfley, Pike, Dohm, & Kraemer, 2005).

Relationship quality between youth and parents is associated with diet and exercise in children and youth. In order for youth to change unhealthy habits, they need to feel that those changes and related behaviors (e.g. healthful eating, regular physical activity) are important to their parents (Little & Brownell, 2003). Parents communicate

that they value these activities for their children through support and positive communication (Little & Brownell, 2003). Negative parent-child relationships are associated with more extreme eating behaviors (Archibald, Graber, & Brooks-Gunn, 1999) while positive, supportive interactions are associated with increased fruit and vegetable consumption (Young, Fors, & Hayes, 2004; Blanchette & Brug, 2005).

### *Monitoring*

In addition to the relationship between the parent and adolescent, the level of supervision and knowledge a parent has in relation to their child's food intake is also associated with adolescent weight and food choices. Parental monitoring is described as the level of information the parent has about their child, their whereabouts, and their activities (Maccoby & Mnookin, 1992). More recently, the discussion of parental monitoring in the parenting literature has evolved. Researchers now suggest what we once labeled monitoring actually includes indicators of parental knowledge (Kerr & Stattin, 2000). This construct recognizes that a key role in adolescent-parent relationships is how teens provide information to parents. Now instead of viewing the parent as the monitor of child activity, we recognize the role of the teen in providing information to a parent. The literature about parental knowledge and food consumption focuses on parent monitoring and how the parents' knowledge influences children's eating and physical activity behaviors. While monitoring is an important contributor to child health, and gives the parents the opportunity to supervise and correct health choices and behaviors (Faith & Berkowitz, 2004) it is a limited idea. Even so, moderate levels of parent monitoring are associated with positive outcomes in children, while extreme levels of monitoring are associated with harmful outcomes (Laird, Dodge, Bates, Criss, 2001). Consistently,

extreme levels of monitoring (high or low) are associated with obesity in children and adolescents (Ogden, Reynolds, & Smith, 2006; Turner, Rose, & Cooper, 2005).

Excessive monitoring by fathers is associated with overweight in girls (Turner, Rose, & Cooper, 2005) and parents with overweight children report higher levels of monitoring and restriction of food and meals (Moens, Ghent, Braet, & Soetens, 2007). These associations are significant independent of the effects of parent BMI and socio-economic status (Moens, Ghent, Braet, & Soetens, 2007).

Conversely, moderate levels of monitoring are associated with positive outcomes in youth, including weight loss for children with overweight (Faith, Berkowitz, 2004). These and other findings suggest a curvilinear relationship between parental monitoring and health behaviors, with moderate levels producing the most desirable outcomes (Arredondo et al., 2006; Faith & Berkowitz, 2004; Moens, Ghent, Braet, & Soetens, 2007; Neumark-Sztainer, Story, Ireland, & Resnick, 2002). More specifically, in one study moderate parental monitoring increased physical activity in boys, while high levels of monitoring actually decreased activity in boys. For girls, high levels of monitoring led to extreme dieting behaviors (including skipping breakfast), while moderate monitoring led to regular breakfast eating (Neumark-Sztainer, Story, Ireland, & Resnick, 2002). Each of these studies utilized food-specific measures to address monitoring.

A laboratory study by Laessle, Uhl, and Lindel (2001) found that parental monitoring may change the eating behaviors of overweight children. The researchers found that when children with overweight ate a meal without their mothers present, their eating behavior such as bite size and frequency was very similar to normal weight children. Conversely, when overweight children ate a meal with their mother close by,

they ate more food in larger and faster bites than when mothers were not present. Their finding suggests a learning model induced by high parental monitoring of food intake at home (Laessle, Uhl, & Lindel, 2001). The amount of information parents have about their child's food choices gives them the opportunity to influence said choices. Thereafter, the level of control a parent has versus the level of control an adolescent has in making food-related choices impacts the adolescent's health and weight.

#### *Parent Control and Limit Setting*

Parental control levels and limit setting practices also influence child and adolescent overweight and health behaviors. Faith, Scanlon, Birch, Francis, and Sherry (2004) found that high control over feeding, including high feeding restriction, was associated with increased calorie intake and weight. Beyond the effects of parent BMI and socioeconomic status, parents of obese children placed more restriction on food than parents of normal weight children (Moens, Ghent, Braet, & Soetens, 2007). This cross-sectional study cannot answer questions of causation, but it does illustrate an important association between restriction and obesity.

Indeed, parental restriction is frequently maladaptive and ineffective (Fisher & Birch 1999; Moens, Ghent, Braet, Soetens, & 2007). Fisher and Birch (1999) found that parents of children with overweight had significantly higher levels of feeding restrictions. They also found a positive linear relationship between the level of mother restrictiveness and the amount of unhealthy snack food that was eaten when mothers were not around. Restriction predicted child body fat, with higher levels of food restriction leading to higher percentages of body fat in the children (Fisher & Birch, 1999).

Parental control and restriction are important covariates of child and adolescent health behaviors. Generally, parental control can be classified as overt or covert, based on the characteristics of the strategies involved. Overt control includes behaviors such as threats of weight gain (Herriot, Bishop, & Truby, 2003) and verbal prompts to eat more or less (Hill, Brechwald, Dodge, Pettit, & Bates, 2007). Overt control has been linked to healthier behaviors in children in that they tend to eat fewer unhealthy foods such as “junk” foods and convenience foods. On the other hand covert control, a more indirect strategy, is associated with healthy behaviors and a higher prevalence of consuming healthy foods such as fruits and vegetables (Ogden, Reynolds, & Smith, 2006). This illustrates that both forms of control can be effective, and that there are ultimately two elements to improving children’s diets: encouraging less unhealthy food and more healthy food. These forms of control appear to attend to both in unique ways.

In sum, regardless of specific strategy used, high levels of control appear to be counterproductive (Birch 1999). When parents strongly control children’s food intake, children eat fewer fruits and vegetables (Birch, 1999). Researchers and practitioners suggest flexibility and responsiveness regarding diet; they recommend providing healthy choices and permitting the child to regulate their intake (Johnson & Birch , 1994). In fact, when parental control is used excessively, children lose the ability to regulate caloric intake (Johnson & Birch , 1994). A common characteristic of overweight children with highly controlling parents is the incapacity to respond to physiological cues of satiety, leading them to eat more calories (Johnson & Birch, 1994). Children with overly controlling parents eat more when prompted to do so and have increased rates of obesity (Hill, Breechwald, Dodge, Pettit, & Bates, 2007).

Parent self-reports of controlling behaviors are connected to their perception of their child's weight. Mothers who perceive their child to be overweight tend to be more restrictive than mothers who do not have these perceptions (Francis, Hofer, & Birch, 2001). These circumstances appear to catapult the parent into a restrictive mindset, but when enacted it typically does not produce the intended results of weight loss or maintenance (Birch, 1999; Francis, Hofer, & Birch, 2001).

There is some evidence that control strategies and their effects differ by race. In a study of Hispanic and African American parent feeding strategies, the authors found that Hispanic parents practice higher levels of control and their children have higher risk of obesity than African American parents. Although control was highly used by African American parents, it was found to be used less frequently by parents of African American boys who were overweight (Hughes et al., 2006). This is contrary to the increased parental control found in parents of Caucasian overweight children (Francis, Hofer, & Birch, 2001). No type of control was associated with overweight in African American girls (Hughes et al., 2006).

### *Family Meals*

Family routines are an important family process in predicting child overweight and eating behaviors. Family meals provide an environment for the above family processes, both in food-specific and globally measured processes, to be enacted and influence adolescent diet, food intake, and overall weight status. Family meals are influential routines for children and adolescents (Neumark-Sztainer, Wall, Story, Fulkerson, 2004). One study reported that when parents make family meals a priority and a frequent occurrence, and when they create a positive atmosphere for meals, children

have healthier diets and less disordered eating, including binge eating. This relationship was partially mediated by family connectedness, but nevertheless had a significant direct effect on child eating behaviors (Neumark-Sztainer, Wall, Story, & Fulkerson, 2004). A study from the Adolescent Health (Add Health) data set found that parents who regularly ate evening meals with their children had children who were less likely to skip breakfast and had higher rates of healthy food consumption including fruits, vegetables, and dairy (Videon & Manning, 2003). Other studies support the relationship between frequency of family meals and increased intake of vegetables and fruits, whole grains, and dairy (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). Family meals are also negatively associated with soft drink consumption (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). A longitudinal study by Mamun, Lawlor, O'Callaghan, Williams, and Najman (2005) found that mothers' positive feelings toward eating family meals was associated with a lower BMI percentile in adolescents. Some researchers suggest that it is not the frequency of family meals that are important, but rather how highly the parents rate the importance of eating together (Mamun, Lawlor, O'Callaghan, Williams, Najman, 2005).

Family meals, as a routine, also appear to provide opportunity for other family processes to influence child eating behavior. At family meals children are generally responsive to parental prompts to eat more or less (Hill, Brechwald, Dodge, Pettit, & Bates, 2007); these prompts can be considered indicators of monitoring and control levels by the parents. Children usually do comply with these requests, with the exception of requests based on threats to withdraw privileges and portion control. They are responsive to power assertion, rewards (for example, a dessert for finishing the vegetables), and

neutral prompts to eat (Hill, Brechwald, Dodge, Pettit, Bates, 2007), making the interaction between this routine and parenting practices important in weight control (Hill, Brechwald, Dodge, Pettit, & Bates, 2007).

### *Socioeconomic-Status and Overweight*

Socioeconomic-status is closely related to overweight and influences it in a number of strong indirect ways, though there is recent evidence to suggest that the link between SES and obesity is weakening (Wang & Zhang, 2006). On average, individuals living in disadvantaged neighborhoods have higher body mass indexes than those living in more prosperous areas (Inagmai, Cohen, Finch, & Asch, 2006). This relationship appears to be mediated by level of education and food availability. Children of parents who are less educated consume healthful foods such as vegetables, fruits, and dairy at lower levels (Videon & Manning, 2003). There is evidence to suggest that across different cultures, families of lower SES consume fewer fruits and vegetables, exercise less, consume more fat, and consume fewer essential vitamins and minerals than higher SES families (Ball, Crawford, & Mishra, 2006; Shahar, Shai, Vardi, Shahar, & Fraser, 2005). Also, the cost of healthful foods, such as fruits and vegetables, is negatively associated with intake and may account for part of the discrepancy between SES groups and diet (Caballero, 2006). Parents from lower SES tend to be more concerned with adequate food quantity than with nutritional quality and focus on protecting the social aspects of mealtimes over concern for nutritional elements (Herriot, Bishop, & Truby, 2003). Within socioeconomic status, there are also distinct racial differences. African Americans consistently have higher rates of obesity than Whites, even within the same SES group (Wang & Zhang, 2006). This may be related to the finding discussed above

that African American children have diets higher in fat and sugar than White children (Videon & Manning, 2003).

Family processes that influence childhood obesity and health behaviors are also significantly affected by socioeconomic status (SES). SES is positively related to the frequency of family meals, which have been shown to produce healthy diets and behaviors (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). Parental control strategies also vary by SES. Parents with lower SES report using threats of weight gain and other overt strategies more frequently than parents with higher SES (Herriot, Bishop, & Truby, 2003). Higher SES parents report using covert strategies more frequently due to their fear of encouraging an eating disorder through overt statements. They were also less likely to offer alternative food choices when children disliked what was offered (Herriot, Bishop, & Truby, 2003).

#### *Research Questions and Hypotheses*

With the above research in mind, the current study addresses two research questions. First, do global family processes influence youths' BMI percentile over time above the influence of mothers' BMI? It is hypothesized that global measures of family processes will demonstrate associations with BMI percentile similar to previous studies with primarily food-specific measures even when mother's BMI is considered. Second, do demographic variables, such as sex, race, income, and family structure, predict differences in BMI percentile? It is hypothesized that that lower income adolescents and adolescents from minority groups will experience a greater increase in BMI percentile over time than higher income adolescents and Caucasian adolescents.

Specifically, it is anticipated that positive parent-child relationships, authoritative parenting, frequent family meals, high monitoring, and moderate control will be associated with healthier BMI percentiles or weight loss over time. Conversely, negative parent-child relationships; permissive, uninvolved, or authoritarian parenting; low frequency of family meals, low monitoring, and high control will be associated with increases in BMI percentile over time.

Control is anticipated to have a curvilinear relationship with BMI percentile due to its scaling: moderate scores indicate that parents and children set limits together, while lower scores indicate little parental contribution to limit setting and higher scores indicate little child contribution to limit setting. Monitoring, though frequently seen as having a similar curvilinear relationship with child outcomes, is hypothesized to have a negative linear relationship with BMI percentile. This is due to the nature of the measure; the measure does not contain items measuring intrusive monitoring. Also, analysis of children reporting low and high monitoring in the NLSY97 show that children who report high monitoring have fewer negative outcomes such as substance abuse, delinquency, behavioral and emotional problems (Child Trends, 1999).

#### *Methodological Contributions*

This study contributes to the field of family processes and overweight in four significant ways. First, it includes multiple data points over an extended period of time. Previous studies are typically cross-sectional or cover limited time-periods, such as one year or less (for review see Faith, Scanlon, Birch, Francis, & Sherry, 2004; Ogden, Reynolds, & Smith, 2006). Correlational results produce findings that limit our understanding about family and weight gain over time. The current study answers this

problem and includes multiple data points over time which helps us understand the directional effects of family processes on overweight.

The second contribution to the literature is the diverse large sample of the NLSY97. A common methodological problem facing current studies of family processes and overweight is that these studies frequently include small, non-representative samples (Griffin, Toney, & Hardeman, 2003; Archibald, Graber, & Brooks-Gunn, 1999). These samples are typically made up of European-Americans and do not include large numbers of participants (for review of samples in childhood obesity literature see Griffin, Toney, & Hardeman, 2003).

Third, this study simultaneously examines the effect of multiple family processes on childhood obesity, including their interactions. Most previous studies have only measured one family processes variable, such as parenting style or control, as it relates to youth overweight (Archibald, Graber, & Brooks-Gunn, 1999; Germann, Kirschenbaum, & Rich, 2007; Turner, Rose, & Cooper, 2005). By studying multiple processes simultaneously, the current study can examine the association between family process and adolescent overweight vis-à-vis other family processes.

Finally, this study uses global measures of family processes as predictors of childhood overweight rather than family process measures that relate to food consumption only. Most studies of family processes and childhood overweight use measures specific to food consumption (Germann, Kirschenbaum, & Rich, 2007; Orrell-Valente, Brechwald, Dodge, Pettit, & Bates, 2007; for review see Kitzmann & Beech, 2006). This study will assess whether global measures of family processes have similar associations between family processes and youth weight.

## Chapter III

### Methods

#### *Sample*

The National Longitudinal Survey of Youth 1997 (NLSY97) dataset is used in the current study. The NLSY97 is coordinated by the U.S. Bureau of Labor Statistics and focuses on the educational and labor experiences of youth as they transition into adulthood and into the labor force. In addition to items measuring these domains, the NLSY97 includes data on family characteristics, family processes, and the health of the adolescent. Wave one data collection in 1997 included interviews with the youth and one parent; subsequent waves included youth interviews only. Data from 1997-2004 are currently available for public use (U.S. Bureau of Labor Statistics, 2007). The U.S. Bureau of Labor Statistics reports that the NLSY97 is a national sample of 8,984 youths age 12-16 as of December 31, 1996. According to the Bureau of Labor Statistics, only youths aged 12-14 as of December 31, 1996 were asked the family process questions. Although this is the methodology commonly reported, some youths over age 12-14 as of December 31, 1996 were asked the family processes items due to the inclusion of siblings in the sample (Day, 2008).

The sample for the present study includes 4,688 youths who were asked the family process questions and were 12-14 years old at wave one data collection. The sample is 49 percent female and 51 percent male. Due to the oversample design of the NLSY97 the sample is diverse: 52 percent Caucasian, 26 percent African American, 21 percent Hispanic, and 1 percent other. Fifty-one percent of the sample lived with both biological parents at the time of wave one data collection, 16 percent lived with a single

mother, and 26 percent lived in a step-parent family structure including married and unmarried biological, adoptive, step, and cohabiting parents. In wave one of data collection 66 percent of adolescents were normal weight, 14 percent were at-risk for overweight, and 10 percent were overweight. Approximately 6 percent of the sample were missing BMI information in wave one. Due to the focus of this study, underweight adolescents were not included. It was important to exclude these adolescents since weight gain is medically desirable for this group.

A unique feature of the NLSY97 among nationally representative datasets is its inclusion of siblings in the sample. The NLSY97 is not intended to be a nationally representative sample of siblings; rather, multiple youths were selected from households for reason of cost and time efficiency. Due to this sampling technique twenty-one percent of the total NLSY97 sample is non-independent (Day, 2008). The sample for this study is 20 percent non-independent with 18.5 percent of children participating with one sibling, one-and-a-half percent participating with two siblings, and less than .001 percent (one family) participating with three siblings. See Table 1 for a more detailed description of non-independent data by race, gender, and age. With the exception of the racial group “other”, there does not appear to be differences in the percentage of multiple-respondent households between races, gender, or age.

### *Independent Variables*

Family process variables for the current study were selected from the Family Processes section of the NLSY97 prepared by Child Trends, Inc. and the Center for Human Resource Research at The Ohio State University. See Table 2 for the means, ranges, and standard deviations of the overall NLSY97 sample and the subsample for this

study. A comparison of the means and standard deviations of the NLSY97 sample and the subsample used in this study shows that the distributions are nearly identical.

### *Parenting Style*

Parenting style was measured through the combination of two constructs: supportiveness and strictness. These domains are frequently used as measures of parenting style (Maccoby & Martin, 1983). Supportiveness was measured with one question asking how supportive the youth felt their parent was toward him/her. This was measured on a three-point scale: “not very supportive”, “somewhat supportive”, and “very supportive”. Scores were coded so that higher scores indicated higher supportiveness. Strictness was measured by one question asking whether the parent was “permissive or strict about making sure you did what you were supposed to do.” Answers were coded as 1 = “permissive” and 2 = “strict”. Four parenting styles were derived from combining the levels of the two variables: uninvolved, permissive, authoritarian, and authoritative.

Youths were asked this information separately for each parent, including residential and non-residential mothers and fathers. The items were developed by researchers at Child Trends, Inc. with the goal of creating a short measure to assess parenting style. This measure was selected for inclusion in the model due to the associations found in the literature between parenting style and weight-related characteristics (Fairburn, Wilfley, Pike, Dohm, & Kraemer, 2005; Moens, Ghent, Braet, & Soetens, 2007).

### *Parent-Child Relationship*

To assess the quality of the parent-child relationship, youths were asked to respond to three statements regarding their feelings towards their parent on a five-point scale ranging from “strongly disagree” (equals zero) to “strongly agree” (equals four). These statements were: 1) “I think highly of him/her”; 2) “She/he is a person I want to be like”; and 3) “I really enjoy spending time with him/her”. In addition, youths were asked to respond to five more questions on a five-point scale ranging from “never” (equals zero) to “always” (equals four). The questions assessed constructs such as frequency of parental praise, criticism, helpfulness, and dependability. For example, youths were asked, “How often does s/he praise you for doing well?” Negative questions were reverse coded and the youth’s responses to the eight items were summed to create an overall score for the parent-child relationship. Scores range from 0 to 32; higher scores represent a more positive relationship. The internal consistency for the items was high: for residential mother  $\alpha = 0.75$ ; for residential father  $\alpha = 0.82$ ; for non-residential mother  $\alpha = 0.85$ ; for non-residential father  $\alpha = 0.83$ . These questions were asked separately for mothers and fathers, and were asked regarding both residential and non-residential parents.

These scales were adapted for the NLSY97 from items used in the Iowa Youth and Families Project studying family relations amidst economic struggle (Conger & Elder, 1994). Based on previous literature, parent-child relationships appear to influence weight-related behaviors and weight in general (Turner, Rose, & Cooper, 2005; Young, Fors, Hayes, 2004). The measure in the NLSY97 is a scale that creates a global measure of the parent-youth relationship to use in the model.

### *Monitoring*

Youths reported on the level of parental monitoring by responding to four items on a five-point scale ranging from “knows nothing” (equals zero) to “knows everything” (equals four). The question stem was “how much does he/she know about...” followed by statements asking about friends, friends’ parents, who the child is with when they are not at home, teachers, and how the child is doing in school. The responses to the four items were summed to create an overall score representing the level of monitoring. Scores range from 0-16 with higher scores representing higher levels of monitoring. Reliability scores are: alpha = 0.71 for residential mother; alpha = 0.81 for residential father; alpha = 0.85 for non-residential mother; alpha = 0.85 for non-residential father. Youths responded to the items separately for each parent, regardless of parent residential status.

Youth reported monitoring scores separately for mothers and fathers, and residential and nonresidential parents. The items used to assess monitoring are frequently used by a number of researchers (Hetherington, Cox, & Cox, 1982; Maccoby & Mnookin, 1992). Most studies of the effect of parental monitoring on weight related outcomes use food specific measures of monitoring (Arredondo et al., 2006; Faith & Berkowitz, 2004). Using a global measure of monitoring, the present study will examine if monitoring in social and academic domains is related to child BMI percentile.

### *Control, Autonomy, & Limit Setting*

To assess how much control the adolescent has over their choices and the degree to which they participate in limit setting, youths responded to three items on a three-point scale: “parent or parents set limits” (equals 1); “parents let me decide” (equals two); and “parents and I decide jointly” (equals three). Youths responded to three items: “who set

the limits on how late you stay out at night”; “who set the limits on who you can hang out with”; “who set the limits on what kinds of TV shows or movies you can watch”.

Construct validity was assessed through comparing youth and parent responses to the same items ( $t = 10.27$ ;  $p < .001$ ). Since the items were designed to be an index rather than a scale, internal reliability was not addressed. They did not refer to mothers and fathers separately. For index creation, responses were recoded to represent youth setting limits as zero, setting limits jointly as one, and parent setting limits as two. The recoded responses to the three items were summed to create an index score ranging from 0-6, with higher scores representing more parental control.

Control was assessed jointly for both parents. Parents’ control in limit setting was assessed by both youth and parents with strong construct validity. These items were adapted from items that appear in the National Longitudinal Survey of Youth 1979 cohort. Similarly to the literature on parental control and limit setting, previous studies have frequently used food specific measures (Fisher & Birch 1999; Moens, Ghent, Braet, Soetens, 2007). The NLSY97 does not include food-specific questions, but the measure created based on other domains of control will be used to assess the general relationship between control and BMI percentile.

#### *Family Meals*

Youths were asked about the frequency of family meals. Each youth responded to the question, “How many days a week do you eat dinner with your family?” Responses ranged from zero days to seven days. In the current study, this measure is included as a measure of family meals, essentially a proxy indicator for the likely positive influences of

family meals: positive family interaction and more healthful eating (Fairburn, Wilfley, Pike, Dohm, & Kraemer, 2005; Neumark-Sztainer, Wall, Story, Fulkerson, 2004).

#### *Other predictor variables*

Family structure, gender, mother's BMI, race, and income will also tested for in the model. Family structure, mother's BMI, and income are measured as family level variables and are constant between siblings in family groups. Fewer than 300 fathers responded to the questionnaire. Adolescents whose fathers participated were coded as missing for mother's BMI data.

#### *Outcome Variable*

##### *BMI Percentile*

The Centers for Disease Control (2000) publish BMI percentiles and percentile cutoffs for persons under 20 years of age: underweight (less than the fifth percentile), normal weight (fifth through 85<sup>th</sup> percentile), at risk for overweight (85<sup>th</sup> percentile to 95<sup>th</sup> percentile), and overweight (95<sup>th</sup> percentile and above). For this study, youths were assigned a BMI percentile based on their height to weight ratio for age (in months) and sex. Height and weight were collected through self-reported data. A study of the accuracy of youth reports of height and weight based on 11,458 youths from the nationally representative Adolescent Health (Add Health) dataset, found that when measured and reported BMI were compared only four percent of adolescents were misclassified by weight status category (Goodman, Hinden, & Khandelwal, 2000).

## Chapter IV

### Results

Changes in BMI percentile over time and its association with family process variables, gender, race, and income were addressed through multilevel modeling with a three level longitudinal model. This approach was important for both theoretical and statistical reasons. Theoretically, a multilevel approach was appropriate because the sample is non-independent; twenty percent of the sample is nested within family groups. Therefore, it was expected that family level variables would influence the growth trajectories of siblings. Statistically, this is also an appropriate technique because multilevel modeling permits correlated error structures, resulting in appropriate parameter estimates. This is necessary because there were multiple siblings reporting on their family processes. When multilevel models are not employed for multilevel data, such as the NLSY97, unmodeled variance from the lack of multiple levels is pooled into a single error term. This leads to an underestimation of standard errors and increases the possibility of committing Type 1 error (Singer and Willett, 2003).

*Descriptive statistics.* Correlations, means, and standard deviations are displayed in Table 3. As expected, the family process variables were correlated with one another, particularly between mother and father and between monitoring and the parent-adolescent relationship. Mother's BMI were significantly correlated with multiple family process variables such as control, monitoring, parent-adolescent relationships, and family meals. Mother's BMI was also correlated with adolescent BMI at all time points and with family income. Adolescent BMI percentile between years was also highly correlated, as to be expected.

*Statistical analysis.* Data preparation included centering the continuous predictor variables at the sample's grand mean so the regression coefficients could be interpreted as the effect of a predictor set to its mean, or in other words interpreted for the average person in the sample. Grand mean centering is a process of subtracting all observed variables from the sample's mean for that variable. Therefore, results are interpreted as being the effect of that variable for the average individual in the group. Additionally, sample grand mean centering may limit the influence of possible multicollinearity in multilevel modeling. Since the current study included multiple parenting items that may be related, correlation matrices and variance inflation factors (VIF) were examined for possible multicollinearity between variables. Only two variables, father-adolescent relationship and father monitoring, were likely affected by multicollinearity with a VIF for each variable of 53.8. All other VIFs for the variables in the study were less than two. Father relationship was selected to be tested as a level one variable. Additionally, respondents who replied that their race was "mixed race" were not included in analyses due to the small size of the group (83 respondents) and the resulting lack of statistical power. Adolescents classified as underweight (141 respondents) were also excluded from the sample due to the small size of the group and due to the fact that underweight adolescents should be gaining weight for medical reasons.

The software program SPSS was used to analyze the three-level longitudinal model. The *within* or individual level (level one) covariates tested included the youth report of family process variables: parenting style, monitoring, parent-youth relationship, frequency of family meals, and parental control as well as adolescent gender and

adolescent race. At the *between* or family level (level two) the covariates included the family-level predictors of mother BMI, family income, and family structure.

Model comparisons were made by measuring the change in model -2 log likelihood values, Akaike's Information Criterion (AIC) and Schwarz's Bayesian Criterion (BIC), with the model showing the lowest scores being selected as the final model. The -2 log likelihood indicates how closely the model fits the data and follows a chi square distribution. It is used to calculate the deviance statistic, also referred to as the chi square difference test, to aid model selection and model fit measurement. The -2 log likelihood is used to calculate the AIC and the BIC, though both information criteria indexes incorporate the number of parameters estimated in the model. This approach penalizes models that are less parsimonious. In other words, the AIC and the BIC both increase as the number of estimated parameters increase. Therefore the AIC and BIC make it more advantageous to use fewer strong predictors than risk over-fitting the model with more, weaker predictors to achieve a good -2 log likelihood model fit. Since low scores on the information criteria indexes and significant changes in the -2 log likelihood were selected in addition to parameter significance, parameters that were not significant but led to a significant improvement in model fit were included in the model. Finally, a pseudo- $R^2$  was calculated for each conditional model (predictors included) to represent the percent reduction in variance accounted for by the predictors. It is used in place of the usual  $R^2$  in multilevel growth models and is calculated by comparing the change in variance components as predictors as added to the model. In other words, by comparing the residual variance of the unconditional (no predictors) model to the conditional (with predictors) model, the pseudo- $R^2$  provides a percentage indicating the reduction in

variance when predictor variables are added to the model. If adding predictors to each level of the model explains a significant portion of the variance, then the pseudo- $R^2$  is expected to increase.

The unconditional model was tested first (See unconditional model in Table 4). This model included no predictors and created the basis from which to compare subsequent models. The unconditional intraclass correlation coefficient (ICC) was calculated for this model. The unconditional ICC indicates the proportion of variability due to grouping at the between level in comparison to within person variability. In this case, the between level variability refers to differences between families and the within level variability refers to change in individuals over time. The ICC indicates the degree to which the data are non-independent, with a large intraclass correlation suggesting multilevel modeling is necessary. For the unconditional model the intraclass correlation coefficient for BMI percentile was 0.72. In other words, approximately 72% of the variation in adolescents' BMI occurs between adolescents, due to membership within families and family level variables, as opposed to within adolescents over time due to individual level variables. The unconditional model included an intercept of 60.43. This intercept, indicating that the mean value for BMI percentile in the sample was 60.43, was different from zero. This model also included a significant random intercept indicating a significant amount of variation around the group mean BMI percentile. See Table 4 for the results of the unconditional model.

Second, a model was tested that included time as a predictor (see Table 4). The fixed effect of study wave was significant in the model ( $F=18.36$ ,  $p < .000$ ) with a regression coefficient of -0.41. This can be interpreted as each subsequent wave of the

study is associated with a -.41 BMI percentile change. This model represented a slight improvement in information index criteria and a significant decrease in -2 log likelihood by 1752.55 with two degrees of freedom. The psudeo-R<sup>2</sup> was 18.86%, indicating that approximately 19% of the variation between levels is accounted for by change over time.

In a third model time was tested as having a random slope. This resulted in a small but significant decrease in the -2 log likelihood value (9.25 with 1 degree of freedom,  $p = .002$ ) and a slight improvement in the information criteria indexes. The pseudo R<sup>2</sup> increased to 25.50%. The regression coefficient of study wave remained at -.41. The random slope for study wave did have significant variance parameter estimate of 11.96, Wald's  $z = 13.67$ ,  $p < .000$ . The Wald's  $z$  tests if the amount of variance is significant. These tests indicate that there is significant variance around the effect of time for the group.

Next, level one predictors were introduced into the model with a forward regression approach. Only significant predictors or predictors that led to improved information criteria indexes and significant decreases in the -2 log likelihood were included. This resulted in the inclusion of parental control, family meals, race, sex and father's parenting style. Mother and father monitoring, mother-adolescent and father adolescent relationship, mother's parenting style were not significant and did not remain in the model. A quadratic term for parental control was tested and was not significant. All interaction terms were tested for level one variables, resulting in two significant interaction terms in the final model: father's parenting style by control and sex by race. All possible interactions were tested due to the belief in the possible moderating effect of many of the variables, such as income, mother's BMI, and family processes values, as

suggested by previous literature and by significant correlations between these variables in this sample.

*Statistical results.* Once level one predictors were added, the study wave indicator was no longer a significant predictor of BMI percentile ( $p = .11$ ). The intercept of 51.48 remained different from zero. Since the continuous predictor variables were grand mean centered, the intercept is interpreted as the BMI percentile when all predictors in the model are set to their sample grand mean. In other words, 51.48 represents the BMI percentile for the person in the group with an average score on all predictor variables. The random intercept was also statistically different from zero. Tests of fixed effects indicated that race, sex, parental control, frequency of family meals, and father's parenting style were significant predictors of BMI percentile. This model resulted in a significant decrease in the -2 log likelihood value (55804.89), a large decrease in the AIC and BIC information criteria indexes, and a moderate increase in the pseudo  $R^2$  to 32.84% (See Table 4). The regression coefficient for family meals was -.53, meaning that for each one day increase in the frequency of family meals, the BMI percentile decreased by .53 points. A one unit increase in parental control was associated with a .47 percentile increase in the BMI percentile. For father's parenting style, an uninvolved parenting style or an authoritarian parenting style was associated with a -3.48 and -1.74 change in the BMI percentile intercept when compared to authoritative fathers. In this model, males reported a 7.48 percentile higher the intercept, or mean starting value, than females. Additionally, race was a significant predictor: African Americans reported a mean starting percentile 14.08 points higher than Caucasians while Latinos had a mean starting

percentile 7.22 points higher than Caucasians. These results for this model are included in Table 4.

The interaction term for sex by race was significant. For males, the estimated marginal means of these variables, even when controlling for the other predictors in the model, demonstrated significant differences. African American males had a .71 point higher BMI percentile mean than Latino males, while Latino males had a BMI percentile mean 4.8 points higher than Caucasian males. African American males had a 4.15 point higher BMI percentile mean than Caucasian males. For females, the differences were greater. African American females had a mean percentile that was 6.86 points higher than Latino females and 14.08 points higher than Caucasian females. Latino females had a mean BMI percentile 7.22 points higher than Caucasian females. The interaction term for father's parenting style and control was also significant. The interaction of control and an uninvolved style was 3.41 percentile points lower than the interaction of control and an authoritative style. The interaction of control and an authoritarian style was significant and was 1.7 percentile points lower than the interaction for control and an authoritative style.

The next step of this model testing strategy was to include the level two (family level) predictors in the model. Mother's BMI, family income, and family structure were tested. Mother's BMI had a significant main effect with an F test of 103.07,  $p < .000$ . Family income did not have a significant effect, possibly due to the inclusion of other measures such as BMI and race, but was included in the model due to its significant effect on the -2 log likelihood and the information criteria indexes. Including family income was associated with a 9340.68 decrease ( $p < .000$ ) in the -2 log likelihood, a

9504.64 decrease in the AIC, and a 9333.98 decrease in the BIC. Family structure was not significant and did not improve model fit, therefore it was not included in subsequent models. No level two interaction terms or cross level interaction terms were significant.

The inclusion of level two predictors in the model resulted in two changes in significant main effects. In the model with only level one predictors, parental control was a significant main effect and father's parenting style was a significant main effect. After introducing mother's BMI and family income, parental control and father's parenting style were no longer significant at the  $p < .10$  level. Retaining parental control and father's parenting style in the model with level two variables was not associated with a better or worse model fit (-2 log likelihood change of .71) but the variables were retained in the model since their inclusion contributed to a significant interaction term.

*Final model.* The final model included a random intercept, time as a predictor with a random slope, level one predictors, and level two predictors. The formula for the final model is below:

Level-one model

$$Y_{ijk} = \beta_{0jk} + \beta_{1jk} \text{TIME1} + e_{ijk}$$

Level-two model

$$\beta_{0jk} = \beta_{00k} + \gamma_{01} X_{\text{SEX2}} + \gamma_{02} X_{\text{RACE2}} + \gamma_{03} X_{\text{MEALS2}} + \gamma_{04} X_{\text{CONTROL2}} + \gamma_{05} X_{\text{FATHER-PARENTING2}} + \gamma_{06} X_{\text{SEX2}} * X_{\text{RACE2}} + \gamma_{07} X_{\text{CONTROL2}} * X_{\text{FATHER-PARENTING2}} + u_{0jk}$$

$$\beta_{1jk} = \gamma_{10} + u_{1jk}$$

Level-three model

$$\beta_{00k} = \gamma_{000} + \gamma_{001} X_{\text{INCOME3}} + \gamma_{002} X_{\text{MOMBMI3}} + u_{00k}$$

### Full model

$$Y = \gamma_{000} + \gamma_{001}X_{\text{INCOME3}} + \gamma_{002}X_{\text{MOMBMI3}} + \gamma_{01}X_{\text{SEX2}} + \gamma_{02}X_{\text{RACE2}} + \gamma_{03}X_{\text{MEALS2}} + \gamma_{04}X_{\text{CONTROL2}} + \gamma_{05}X_{\text{FATHER-PARENTING2}} + \gamma_{06}X_{\text{SEX2}} * \text{RACE2} + \gamma_{07}X_{\text{CONTROL2}} * \text{FATHER-PARENTING2} + \gamma_{100}\text{TIME1} + \text{TIME1} * u_{1JK} + u_{00K} + u_{0JK} + e_{IJK}$$

Table 4 lists the results from the final model. Level one predictors were sex, race, frequency of family meals, study wave, parental control, father's parenting style, sex by race, and control by father's parenting style. Level two predictors included mother's BMI and family income. As discussed above, all other main effects and interaction effects were not significant nor did they contribute to significant improvement in model fit. The final model had a -2 log likelihood value of 54572.25; AIC 54616.25; and BIC 54765.91; the pseudo  $R^2$  was 33.87%. The conditional intraclass correlation coefficient was calculated for the final conditional model with a coefficient of .58. This coefficient is interpreted as the proportion of variance attributed to membership within families within the final conditional model. This suggests that there was a substantial decrease from the unconditional intraclass correlation coefficient of .72 due to the inclusion of predictors. The within level variance decreased by 33.79 percent from the unconditional model (230.65) and the between level variance decreased by 63.32 percent from the unconditional model (583.88).

The effects of father's parenting style, parental control, study wave, and income were not significant in the final model, but were incorporated due to their inclusion in significant interaction terms or contribution to model fit. The inclusion of family meals into the model was not statistically significant but was strong enough to suggest a strong trend ( $p = .080$ ). Although no longer significant at  $p < .05$ , study wave also continued to be significant at the trend level ( $p = .064$ ). Table 5 shows the F tests and significance

levels of the variables in the model. All other fixed effects were significant with adolescent sex having the largest level one F value ( $F = 18.38, p < .000$ ). The second largest fixed effect was race with an F value of 9.51,  $p < .000$ . Frequency of family meals had a trend level significant level one main effect ( $F = 1.78, p = .080$ ). The two interaction terms included in the model had significant F tests. Control by father's parenting style interaction was tested with an F value of 5.09,  $p = .002$ , and sex by race interaction was tested with an F value of 6.28,  $p = .002$ . The largest effect for level two (family level) variables, and for the model overall, was mother's BMI ( $F=103.07, p<.000$ ). Family income was included in the model but was not significant ( $F=1.68, p = .170$ ).

The regression coefficients for the final model are included in Table 4. Although significant before level one and level two predictors were included, study wave was no longer significant in the final model ( $p = .070$ ). The intercept of 54.02 was different from zero ( $p < .000$ ). This is interpreted as the starting BMI percentile for the average person in the group, based on the centered predictors. The random intercept was also statistically different from zero, indicating that there is significant variation in the starting BMI percentile for the sample. The random intercept for study wave remained statistically different from zero and demonstrates a significant amount of variation in the association between time and BMI percentile.

Sex, race, and frequency of family meals also had significant main effects on the slope of BMI percentile. Being male was associated with a 7.94 percentile points increase in BMI percentile. African American adolescents and Latino adolescents had significantly higher BMI percentile points than Caucasian adolescents, with being

African American associated with a 12.54 percentile points increase in the mean of BMI percentile and being Latino associated with a significant 5.45 percentile points increase in the mean of BMI percentile. A one unit increase in frequency of family meals was associated with a -.48 percentile point change in BMI percentile. At the between level, a one unit increase in mother's BMI was associated with a 1.06 percentile change in the adolescent's BMI percentile. The grand mean centered range of mother's BMI was -11.55-41.24.

The two significant interaction effects in the final model included level one predictors. The first significant interaction term was between adolescent sex and adolescent race. The estimated marginal means, controlling for the effects of the other variables, revealed an association similar to that of the main effect of race: African American and Latino males and females being more likely to have a higher BMI percentile points than Caucasian males and females. This association was more pronounced for females than males with Caucasian females having, on average, a 12.69 percentile points lower BMI percentile points than African American females and a 7.10 percentile points lower BMI percentile points. For males, Caucasians' mean BMI percentile points was 2.01 percentile points lower than African Americans and only 1.15 percentile points lower than Latinos. The second interaction term included in the final model was between parental control and father's parenting style, as displayed in Figure 1. Only the differences between the interaction of uninvolved parenting with control and authoritative parenting with control were significant. The interaction was tested with parallel slopes, but authoritative fathers had a 5.02 BMI percentile higher intercept for control than uninvolved fathers ( $p < .000$ ).

## Chapter V

### Discussion

This study examined the relationships between family processes, demographic variables, and mother's BMI in a longitudinal sample of early adolescents. These findings help illustrate processes that explain adolescent overweight and provide an empirical basis for intervention goals and strategies. Additionally, this study's methodology increases our understanding of how the NLSY97 should be used when considering family processes and key outcomes.

The sample in this study had a slight decrease in BMI percentile over time, though the amount of variation in this effect indicated that the individuals in the sample varied greatly in how their BMI changed over time. Once other predictors were added to the model time was no longer significant. This non-significant slope suggests that trends in BMI percentile for teens may already be established by early adolescence. Therefore, treatment and prevention of overweight in younger groups is critical. Other studies have found childhood weight status to be stable from childhood to adolescence and even adulthood (Brambilla et al., 1999; Sandhu, Ben-Schlomo, Cole, Holly, & Davey-Smith, 2005) and the current study contributes to this body of literature.

Contrary to the hypotheses proposed in this study, parental monitoring, parent-adolescent relationships, and mother's parenting style were not significant predictors of BMI percentile over time. One possible explanation for these findings may be that the family process measures in the NLSY97 were not precise enough to measure how family processes influence health related outcomes. Additionally, monitoring, relationships, and

parenting style as measured by the NLSY97 are not related to food specific situations or feelings.

Even considering the possible imprecision of the NLSY97 measures, the inclusion of non-food specific measures, and the inclusion of mother's BMI family processes do appear to have some influence on adolescent BMI percentile. Bivariate correlations demonstrated that adolescent BMI percentile and mother's BMI percentile are potentially correlated with family processes. When a multilevel regression model was employed, these variables were not significant. But the correlations suggest that these constructs should continue to be explored in relation to adolescent weight status.

Even after including mother's BMI in the model, a couple of family related findings do emerge. Since genetics have been established as an influential element of weight status and weight gain (Marti & Martinez, 2006), it is noteworthy that even when a rough measure of genetics is included in the model some family process findings are or approach significance. Specifically, the incidence rate of family meals was important at the trend level and an interaction effect between parental control and father's parenting style was also significant. These family processes and the significant effect of race suggest that even once the powerful predictor of mother BMI is included family, cultural, and economic influences matter. Prior to the inclusion of the family level variables mother's BMI and income, parental control was positively associated with BMI percentile. Additionally, father's parenting style was associated with BMI percentile before estimating family level parameters with uninvolved fathers and authoritarian fathers having a significantly lower starting BMI percentile than authoritative fathers. Although these predictors were not significant in the final model, this may be evidence

for associations between these family process variables and BMI percentile for certain subgroups within the sample, but do not hold when the sample is considered as a group. For example, differences between normal weight and overweight adolescents should be considered.

Among family process predictors only frequency of family meals was directly associated with BMI percentile at the trend level. This is possibly due to the rate of family meals being the only estimated variable directly associated with food. The negative association between frequency of family meals and adolescent BMI percentile suggests that this food-related family process is associated with a healthier body weight in adolescents. Previous literature indicates that when families eat meals together those meals are more likely to include healthful foods such as vegetables, lower fat portions, and smaller serving sizes which can contribute to children's health (Videon & Manning, 2003). But this influence is likely due not only to the more healthful meals adolescents may eat when dining with family but may also be due to the opportunity family meals present for adolescents to have a positive experience with food in a setting with positive interaction with family members. Eating together provides the time and opportunity to talk with family, discuss concerns and ideas, and have supportive interaction. Family meals have also been suggested as a setting in which children and adolescents can learn healthful eating habits and develop a positive mindset toward food and eating (Neumark-Sztainer, Wall, Story, & Fulkerson, 2004; Videon & Manning, 2003). This may be the result of parents having the opportunity to both instruct their children and model healthy behaviors in a supportive setting. Since this trend-level effect is significant even with the

inclusion of mother's BMI, family meals present an opportunity to influence adolescent weight over and above of the influence of genetics on body weight and weight gain.

The family process variables parental control and father's parenting style remained a significant interaction term after the inclusion of family level variables. This interaction suggests that the influence parental control depends on the type father's parenting style higher parental control is associated with a higher BMI percentile. Adolescents with uninvolved fathers had significantly lower initial BMI percentiles than adolescents with authoritative fathers. Several explanations may exist for this relationship. First, it is possible that this finding is a result of the adolescents' weight itself. Fathers with adolescents who are at a healthy weight and not gaining weight may feel that their involvement is not needed, whereas fathers of adolescents who are gaining weight may increase their involvement by displaying an authoritative style.

Another possible explanation for this interaction focuses on adolescents' reaction to the status quo, or a change in the status quo, of their father's parenting style. Since parental control is positively related to BMI in this interaction, an increase in BMI percentile may be the result of an authoritative father using high control. Adolescents accustomed to an authoritative parenting style may react strongly to this change in family processes through behavioral changes that lead to weight gain. Another important consideration is that the control variable was not measured separately in the NLSY97 for mothers and fathers, therefore creating the possibility that the increased levels of control are due to mothers' control and not fathers'.

As has been established previously (Inagmai, Cohen, Finch, & Asch, 2006; Videon & Manning, 2003), demographic predictors and mother's BMI were important

predictors of adolescent BMI percentile over time. By including a sex by race interaction term, this study was able to describe how BMI percentiles differ for males and females within racial groups. African American and Latino adolescents had higher BMI percentiles, on average, than Caucasian adolescents. In this study this observation was greatest for females, with the difference being much more dramatic between African American and Caucasian females than between African American and Caucasian males. By understanding this interaction better, intervention can be better focused on at-risk groups. Sex alone also influenced BMI percentile such that boys had significantly higher BMI percentiles than females. This result suggests the importance of intervention reaching young boys and adolescent males on issues associated with physical activity and healthy eating.

Income did not have a significant main effect on BMI percentile; this result was unanticipated. This may be due to the inclusion of other variables closely correlated with income, such as mother's BMI and race. Nonetheless, family income was an important contributor when modeling BMI percentile over time. This may suggest that although the effect of income is not significant when closely related factors are considered, income is an important element of understanding the processes and demographic factors behind adolescents' BMI percentile.

Mothers' BMI was strongly associated with BMI percentile. This influence is likely transmitted through two routes. First, adolescents share genetic code with their birth mothers; therefore, adolescents may be more or less likely to gain weight in a high-energy intake and low-energy expenditure environment in response to the paternal and maternal genetic pre-dispositions. Second, the environment mothers provide may directly

correspond to their own weight. Healthier mothers with lower BMIs may be more likely to engage in physical activity and healthful eating themselves, as well as promoting an environment with these values. Likewise, overweight or obese mothers, who are overweight because of life-style, may transmit and teach a more sedentary environment to their children. This environment may additionally include unhealthy food choices and a tendency toward food over-consumption.

*Recommendations for intervention.* These results focus our attention on several intervention strategies. First, according to the data presented here, the best time to target weight control intervention is when children are young: these findings suggest that BMI percentile may be established before early teenage years. Second, these data also suggest that parents should be the target of first interventions with children, especially younger children, since their weight and probably their activity and eating habits map most powerfully on children's unhealthy weight gain among the variables in this study. The overwhelming association between mothers' BMI and adolescents' BMI suggests that focusing on improved general parenting styles or techniques is probably not enough to improve adolescents' health. Instead mothers, particularly low-income mothers, should be provided the education, resources, and programming to improve their own health and the behaviors and habits within their homes.

Wang and Zang (2006) described the link between socioeconomic status and weight as weakening recently. The results of the current study suggest that income and race are deeply intertwined in issues surrounding overweight, and that discrepancies in weight status between groups continue to exist when race is considered. The current

study emphasizes the need to focus research and intervention at groups that are at risk, since it does not appear that risk is equally distributed among racial groups.

These results also indicate that female African-American children are at highest risk and at highest need for intervention. Additionally, these data indicate that Latino girls and boys and African American boys are at particularly high risk of increased BMI percentile. Of course, there are adolescents at unhealthy weights in every demographic category, but these findings are particularly salient for understanding African American and Latino health problems. The effect of group membership on adolescent BMI may mean that cultural, economic, or social influences are important in predicting, preventing, and treating adolescent weight status. These findings suggest the need for fundamental, systemic changes in order to combat adolescent overweight.

The epidemiological and health intervention literature discuss successful intervention in terms of two related, but unique concepts: effectiveness and efficacy (Merrill & Timmreck, 2006). In this body of literature, effective interventions refer to interventions with the ability to produce change, while efficacy refers to the intervention's ability to produce change within the population offered the intervention (Merrill & Timmreck, 2006). For example, effective interventions for adolescent overweight do exist and include changes such as healthier eating, increased physical exercise, and family level changes in diet and health. However, the continued problem, especially among minority and low income populations, may lie in the efficacy of the interventions. This may be due to the fact that these at-risk populations have limited access to healthy foods due to poverty, neighborhood characteristics, school characteristics, or lack of education on healthful eating, making an effective diet-related

intervention unable to be efficacious. In other words, interventions focused on improving diet can be successful, but not if the targeted intervention group cannot afford more healthy food choices such as fruits or vegetables or live in a neighborhood without access to these foods. Other research identifies both income and neighborhood access to healthy foods as factors contributing to consumption of unhealthy foods (Caballero, 2006; Inagmai, Cohen, Finch, & Asch, 2006). In addition to access, issues of education about how to shop for and prepare these foods may also be necessary. Therefore, interventions need to be aimed at reducing the problems associated with access to healthy foods and safe environments in which to exercise in order for education and programming to be successful.

Based on the findings of this study, family dinners may introduce one particularly valuable intervention opportunity. Since frequent family meals are associated with a slight decrease in body weight over time in this and other studies (Neumark-Sztainer, Wall, Story, Fulkerson, 2004; Videon & Manning, 2003), improving family routines or family processes may lead to a variety of positive outcomes in youths and families. Interventions aimed at increasing home meal preparation (instead of fast food consumption) can both place adolescents in proximity of healthier, lower calorie food and possibly place adolescents in a nurturing, positive environment to associate with their families and have positive food-related experiences. As mentioned above, issues associated with access to these foods and education about how to buy and prepare them must be addressed in addition to encouraging families to prepare healthful meals and eat together.

*Methodological Contributions.* This study also made several important methodological contributions to the study of adolescent overweight and to the use of the National Longitudinal Survey of Youth 1997. First, the study's sample and methodology contributed to the general body of literature of using the NLSY97. The NLSY97 sample was larger and more diverse than most studies on the topic, and the current study included four years of data with which to study the influence of family processes and demographic variables over time. Similar studies are frequently cross-sectional or short-term longitudinal (one year or less) (Faith, Scanlon, Birch, Francis, & Sherry, 2004). Additionally, the methodology of the analyses advanced research using the NLSY97 sample by applying a multilevel design. The NLSY97 dataset is frequently misused, with the effects of siblings nested within families being ignored (Day, 2008; Sen, 2006). Other approaches have tried to limit the effect of this non-independence by randomly selecting only one sibling from each family, but this prohibits learning about the effect of family nesting on adolescent development. The multilevel approach was able to not only adjust for the non-independence, but results illustrated that it is critically important that the NLSY97 sample be treated in this manner.

A third contribution of this study was the inclusion of non-food specific measures of family processes from the NLSY97. Most studies of family processes and childhood overweight use family process measures that ask adolescents or parents to respond to items specific to food and eating (Arredondo et al., 2006; Faith & Berkowitz, 2004; Moens, Ghent, Braet, & Soetens, 2007; Neumark-Sztainer, Story, Ireland, & Resnick, 2002). The current study used global measures of constructs such as monitoring, control, and parenting styles as predictors of BMI percentile change over time. Although results

were mixed, these analyses pave the way for more research on the connection between family processes and BMI percentile.

Given the review of the literature, the lack of significant effects of family processes in this study appears to suggest that global family processes are not related to BMI percentile in the ways that food-specific family process measures are related. Parents and adolescents may interact in fundamentally different ways related to food than related to other domains such as friends, academics, and general relationships.

*Limitations.* There are several limitations in the following study. First the pseudo- $R^2$ , a measure of how much variance is explained by the multilevel model with predictor variables, for the final model was still relatively small (33.87%). This suggests that the model lacks important variables in predicting BMI percentile. These may include having measures about adolescents' diet and physical activity, as well as neighborhood characteristics, peers' BMI and peer behaviors, and fathers' BMI. Second, the current study does not explore the differences between clinical BMI percentile groups such as between healthy and overweight groups. More research needs to examine the differences in trajectories and differences in the associations between family processes and BMI percentile for adolescents within these groups.

In conclusion, this study made several important contributions to the field of family processes and adolescent overweight and provided findings to further the efforts to create and implement effective and efficacious interventions. The methodology of this study addressed the necessity of using multilevel modeling when using the NLSY97 in addition to providing a longitudinal design to study changes in adolescent BMI over time. The findings here help direct intervention for those with highest need, males and minority

groups, and suggest where to intervene in order for adolescents and families to achieve optimum health. Namely, interventions should be aimed at helping parents improve their own health and health-related behaviors including increasing the frequency of healthy family dinners. These efforts can benefit individuals and communities in enormous ways by increasing individual quality of life, decreasing medical costs, and increasing productivity.

*Future directions.* Future directions in the study of this topic include using longitudinal designs and multilevel designs, when appropriate. Studies using the NLSY97 should use multilevel modeling. Additionally, improved measures should be used in future studies. Specifically, control should be measured for mothers and fathers separately and multi-item measures for parenting style should be used. When possible, more precise family processes should be used. Future studies should explore differences between adolescents within the different clinical groups and compare the influences of demographic factors and family process variables within normal weight, at-risk for overweight, and overweight adolescents. There may be important differences in the processes that predict change for adolescents in different clinical categories.

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## APPENDIX

*Table 1. Percentage of respondents with one, two, or three siblings in the sample, by group*

	<i>No Siblings</i>	<i>One Sibling</i>	<i>Two Siblings</i>	<i>Three Siblings</i>
<b>Race</b>				
White	82%	17%	1%	0
African American	78%	19%	3%	0.3%
Hispanic	80%	19%	1%	0
Other	69%	24%	7%	0
<b>Gender</b>				
Female	80%	19%	1%	0.1%
Male	81%	18%	1.5%	0.1%
<b>Age</b>				
12	77%	22%	1%	0.1%
13	83.5%	15%	1.5%	0.05%
14	79%	19%	1.5%	0.1%

*Table 2. Sample sizes, means, and distributions of the continuous family processes variables in this study with the means and standard deviations for the NLSY97 sample.*

<i>Family Process Measure</i>	<i>N</i>	<i>Sample Mean</i>	<i>NLSY97 Mean</i>	<i>Sample SD</i>	<i>NLSY97 SD</i>	<i>Range</i>
Autonomy/Control (Youth Report)	3482	3.34	3.34	1.52	1.52	0-6
Autonomy/Control (Parent Report)	3174	4.32	4.28	1.31	1.33	0-6
Frequency of Family Meals	4633	5.14	5.08	2.27	2.27	0-7
Monitoring: Residential Mom	4510	10.33	10.24	3.27	3.30	0-16
Monitoring: Residential Dad	3435	8.27	8.19	4.02	4.00	0-16
Monitoring: Non-Residential Mom	226	7.10	6.83	4.73	4.59	0-16
Monitoring: Non-Residential Dad	596	4.08	3.95	4.05	4.00	0-16
Relationship: Residential Mom	4511	25.18	24.06	4.77	4.83	0-32
Relationship: Residential Dad	3435	24.58	24.50	5.56	5.57	0-32
Relationship: Non-Residential Mom	227	22.76	22.69	7.02	6.82	0-32
Relationship: Non-Residential Dad	594	21.62	21.57	6.60	6.58	0-32

Table 3. Correlations, means, and standard deviations of dependent and independent variables.

	1	2	3	4	5	6	7	8	9	10	11	12
1. BMI Percentile 1997	1											
2. BMI Percentile 1998	.741***	1										
3. BMI Percentile 1999	.717***	.827***	1									
4. BMI Percentile 2000	.697***	.784***	.843***	1								
5. Family Meals	-.054***	-.043**	-.029	-.038*	1							
6. Parental Control	-.018	-.031	-.019	-.019	.117***	1						
7. Income	-.113***	-.113***	-.092***	-.099***	.057**	-.083***	1					
8. Monitoring by mother	.036*	.036*	.025	-.028	-.020	.004	-.046**	1				
9. Monitoring by father	.076***	.058**	.060***	.054**	-.100***	-.124***	-.067***	.587***	1			
10. Relationship with mother	-.041**	-.039*	-.029	-.019	.171***	.164***	.078***	-.038*	-.249***	1		
11. Relationship with father	-.062***	-.084***	-.060***	-.054**	.214***	.119***	.159***	-.195***	-.301***	.484***	1	
12. Mother BMI	.231***	.271***	.249***	.268***	-.061***	.046*	-.165***	.032*	.032	-.036*	-.081***	1
<i>Variable Mean</i>	60.62	60.39	60.04	59.49	5.14	3.34	45865	10.33	8.27	25.18	24.58	27.15
<i>Standard Deviation</i>	28.41	27.77	28.26	28.64	2.27	1.31	41395	3.27	4.02	4.77	5.56	6.20

\* p < .05 \*\* p < .01 \*\*\* p < .001

Table 4. Fixed and random effects in multilevel models predicting BMI percentile.

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$  (standard errors in parentheses)

	Unconditional Model	Model with wave as predictor	Model with wave as random slope	Model with Level 1 predictors	Final Model
<i>Intercept</i>	60.43***(.40)	61.46***(.46)	61.43***(.44)	51.48***(1.13)	54.02***(1.44)
<b>Level 1 predictors fixed effects</b>					
<i>Study Wave</i>	—	-.41***(.09)	-.41***(.88)	-.23(.14)	-.33(.18)
<i>Race—African America</i>	—	—	—	14.08***(1.80)	12.54***(2.26)
<i>Race—Caucasian</i>	—	—	—	reference	reference
<i>Race—Latino</i>	—	—	—	7.22***(1.78)	5.45*(2.29)
<i>Sex—Female</i>	—	—	—	reference	reference
<i>Sex—Male</i>	—	—	—	7.48**(7.48)	7.94***(1.54)
<i>Parental control</i>	—	—	—	.47*(.51)	-.89(.63)
<i>Family meals</i>	—	—	—	-.53*(.23)	-.48(.27)
<i>Father's parenting style—Uninvolved</i>	—	—	—	-3.48**(1.05)	1.31(1.98)
<i>Father's parenting style—Permissive</i>	—	—	—	-.23(.80)	-1.09(1.50)
<i>Father's parenting style—Authoritarian</i>	—	—	—	-1.74*(.86)	2.72(1.61)
<i>Father's parenting style—Authoritative</i>	—	—	—	reference	reference
<b>Level 2 predictors fixed effects</b>					
<i>Mother's BMI</i>	—	—	—	—	1.06***(.10)
<i>Income</i>	—	—	—	—	-.00002(.00001)
<b>Random effects</b>					
Intercept	583.88***(14.4)	245.81***(28.6)	209.62***(27.6)	258.18***(44.3)	213.61***(53.6)
Study wave	—	—	11.96***(.88)	19.75***(1.60)	17.69***(1.93)
<b>Model fit</b>					
-2 log likelihood	146279.60	144527.05	144517.82	88712.93	54572.25
$\Delta$ -2 log likelihood ( $\Delta df$ )	—	-1752.55*** (2)	-9.25** (1)	-55804.2*** (15)	-34136.68*** (2)
AIC	146285.61	144541.06	144533.82	88750.93	54616.25
BIC	146308.74	144595.03	144595.51	88888.24	54765.91
Pseudo- $R^2$	—	18.86%	25.50%	32.84%	33.87%

Table 5. *F* tests for fixed effects in final model

<i>Variable</i>	<i>F Value</i>	<i>Significance Level</i>
<i>Intercept</i>	6415.73	.000
<b><i>Level 1 Independent Variables</i></b>		
<i>Sex</i>	18.38	.025
<i>Race</i>	9.51	.000
<i>Family meals</i>	3.95	.047
<i>Study Wave</i>	3.29	.070
<i>Father's parenting style</i>	1.94	.121
<i>Control</i>	1.77	.183
<i>Sex * Race</i>	6.28	.002
<i>Control * Father's parenting style</i>	5.09	.002
<b><i>Level 2 Independent Variables</i></b>		
<i>Mother's BMI</i>	103.07	.000
<i>Income</i>	1.74	.187

Figure 1. Graph of interaction effect between control and father's parenting style.

### Interaction effect of parental control and father's parenting style

