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Family Income, Maternal Marital Status, Maternal Employment, and the Development of
Overweight and Obesity During Childhood

A thesis
presented to
the faculty of Department of Public Health
East Tennessee State University

In partial fulfillment
of the requirements for the degree
Master of Public Health

by
Shaoqing Gong
August 2010

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Key Words: Longitudinal Study, Childhood Obesity, Overweight, Risk Factor

ABSTRACT

Family Income, Maternal Marital Status, Maternal Employment, and the Development of Overweight and Obesity During Childhood

by

Shaoqing Gong

This study examined the longitudinal associations of family income level, maternal marital status, and maternal employment with body mass measurements and the development of overweight and obesity. Multiple linear and logistic regressions were used to assess the effects of the exposure variables on weight status with simultaneous adjustment for the exposure variables and the covariates. Key findings include: Children in families with incomes below the poverty line at child's 24 or 54 months of age were at a higher risk of becoming overweight and obese at child's third grade than children in families with incomes above the poverty line; longer maternal working hours at child's 54 months of age was associated with an increased risk of overweight and obesity at child's third grade. In conclusion, this study confirms that family poverty status and maternal working hours are associated with child's overweight and obesity risk.

DEDICATION

I dedicate this thesis to all the people who support and love me.

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I have many appreciations. Firstly, I would like to thank my advisor Dr. Tiejian Wu. He not only looks like a professor but also like my family member who always support me with his sincere heart. With his help, I have an interest of epidemiological research, thus I am very excited to finish this thesis.

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CHAPTER 1

INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC) overweight and obesity are determined by body mass index (BMI) which is a practical measure of weight related to height. In adults overweight is defined as a BMI from 25 to 29.9 kg/m², and obesity is defined as a BMI of 30 kg/m² or greater (NIH, 1998). In children (2–19 years of age) overweight is defined as a BMI-for-age greater than or equal to the 85th percentile and less than the 95th percentile on the CDC growth charts. Obesity is defined as a BMI-for-age greater than or equal to the 95th percentile on the CDC growth charts (Flegal, Tabak, & Ogden, 2006).

According to the Institute of Medicine more than 9 million children and young adults older than 6 years are overweight or obese (IOM, 2004). At least 16% of US children were obese and 32% were overweight between 2003 and 2006, and the prevalence of childhood overweight has increased over time (Ogden et al., 2006; Ogden, Carroll, & Flegal, 2008). This prevalence has nearly tripled for adolescents in the past 2 decades (surgeongeneral.gov, 2009). A report from the Foundation for Child Development (Land, 2004) has found that when considering overall health children are faring only slightly better today than they did 30 years ago. Increasing childhood obesity was suggested as a major reason for such slight progress. The estimated 9 million obese and overweight children are at higher risk for type 2 diabetes mellitus, heart disease, cancer, asthma and other pulmonary diseases, high cholesterol, elevated blood pressure, stroke, and other chronic illnesses (Serdula et al., 1993). Compared with normal weight

children, overweight children are 70%-80% more likely to be overweight in adulthood (Pi-Sunyer, 2008).

Study Purpose

Based on data collected from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Development (SECCYD), the objective of this study is to examine the longitudinal associations of family income level (poverty status), maternal marital status, and maternal employment status with body mass measurements and the development of overweight and obesity.

The following hypotheses are tested:

1. Children from single parent households are at a higher risk of overweight and obesity than children from two-parent households.
2. Family income level above the poverty line is associated with a lower risk of childhood overweight and obesity than family income level below the poverty line.
3. More maternal working hours is associated with a higher risk of childhood overweight and obesity.

Significance of Study

The NICHD SECCYD data set provided information of longitudinal assessments of family contexts and child weight outcomes from early childhood to adolescence. As a result, we could conduct a prospective study with a comprehensive analysis of the roles of key family factors including maternal marital status, poverty status, and maternal employment status in the development of childhood overweight and obesity. The analysis of these key factors simultaneously using the longitudinal data from one sample may

provide a better test of their roles as they usually are highly correlated. Family income, maternal marital status, and maternal employment are the fundamental elements for family environments and functions that may directly affect child care. A better understanding of these key family factors in the development of child obesity will have significant public health implications in the prevention and control of childhood obesity and overweight.

CHAPTER 2

LITERATURE REVIEW

Definition and Prevalence

There are various methods to measure body fatness and body thinness (Himes, 1991; WHO, 1995). But considering simplicity and cost issues, height- and weight-based measurements are the most practical tools for assessing nutritional status (Mei et al., 2002). Furthermore, BMI is most commonly recommended and widely used for classifying overweight and obesity in adults (Garrow & Webster, 1985; Keys, Fidanza, Karvonen, Kimura, & Taylor, 1972; Khosla & Lowe, 1967; WHO, 1995;) and has also been recommended for screening overweight and obesity in adolescents (Dietz & Robinson, 1998; Goulding et al., 1996; Himes & Dietz, 1994; Pietrobelli, Faith, et al., 1998; Taylor, Gold, Manning, & Goulding, 1997). According to CDC, BMI is a number calculated from a person's weight and height. BMI provides a reliable indicator of body fatness for most people and is used to screen for weight categories that may lead to health problems. After BMI is calculated for children and teens, the BMI number is plotted on the CDC BMI-for-age growth charts (for either girls or boys) to obtain a percentile ranking. Percentiles are the most commonly used indicator to assess the size and growth patterns of individual children in the United States. The percentile indicates the relative position of the child's BMI number among children of the same sex and age. The growth charts show the weight status categories used with children and teens (underweight, healthy weight, overweight, and obese). BMI-for-age weight status categories and the corresponding percentiles are shown in the Table 1.

Table 1
Weight Status Category Based On Percentile Range

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obesity	Equal to or greater than the 95th percentile

Increases in childhood overweight and obesity have become a major public health problem in industrialized nations (Andersen, 2000; Ebbeling, Pawlak, & Ludwig, 2002). Approximately 17% of children aged 2–19 years are obese as defined by having body mass index (BMI) values at or above the 95th percentiles for age and sex (Stoddard, Kubik, & Skay, 2008). The prevalence of this health issue has increased dramatically among elementary school children, for instance the percentage of children aged 6–11 years who were overweight in 1999–2002 (15.8%) was about three times greater than that in 1970–1974 (4%) (National Center for Health Statistics, 2008). Since 2003 some studies claimed that overweight rate has been stable for the first time; however, the prevalence of overweight for 6-11 years old children was still higher than the target goal, about 5%, compared to that set up by Healthy People 2010 (Ogden, et al., 2008; US Department of Health and Human Services, 2000). In rural areas, the prevalence of childhood overweight is often higher than the national average because of significant health and economic disparities (Demerath et al., 2003; Merten, Wickrama, & Williams, 2008).

Adverse Health Consequences

Numerous studies have explored psychosocial, physical, and economic consequences of overweight and obesity (Paul, 2005). Childhood overweight affects self-esteem and has negative consequences on cognitive and social development (Hesketh, Wake, & Waters, 2004; Tremblay, Inman, & Willms, 2000). Childhood obesity places children at risk for a host of health conditions including hypertension, impaired glucose tolerance, type 2 diabetes mellitus, chronic inflammation, sleep apnea, and orthopedic complications (Hughes & Reilly, 2008; Thompson et al., 2007). Conditions such as type 2 diabetes mellitus, hypertension, and hypercholesterolemia, which were previously seen primarily in adults, are becoming more common among children as the prevalence of obesity increases (Must & Strauss, 1999). Epidemiological research also suggests that childhood obesity endures into adulthood, making early health risks a chronic reality (Freedman, Dietz, Srinivasn, & Berenson, 2009; Lagstrom et al., 2008; Rao, 2006; Schmitz & Jeffry, 2002; Steinberger, Moran, Hong, Jacobs, & Sinaiko, 2001; Thompson et al., 2007; Veugelers, 2005; Wieting, 2007). Thus, childhood overweight often persists into adulthood, and as a result a rising number of adults will be at increased risk of these conditions as well as of cardiovascular disease, osteoarthritis, and certain types of cancer (Dietz, 2004; Manson & Bassuk, 2003). As a whole the obesity epidemic causes a substantial decrease in quality of life and life expectancy and accounts for billions of dollars in health care spending (Fontaine, Redden, Wang, Westfall, & Allison, 2003; Katzmarzyk & Janssen, 2004). Given the severity and course of obesity throughout the lifespan, it is not surprising that national healthcare costs related to the disease approach US\$100 billion per year (Rao, 2006).

Risk Factors

Obesity and overweight are complex, multi-determined conditions. Numerous etiological factors including genetic variability, basal metabolic functioning, environmental influences, and poor health behaviors have been proposed (Schmitz & Jeffry, 2002; Wieting, 2007). There is an accumulation of body fat when calories consumed exceed calories expended. As a result a chronic energy imbalance is produced that leads to further overweight. People overweight or obese has reached epidemic proportions in populations whose environments offer an abundance of calorie-rich foods and few opportunities for physical activity.

Genetic Factors

Obesity is a multi-factorial and heterogeneous condition that results from alterations of various genes, each having a partial and additive effect. The inheritance pattern of obesity is thus complex, and environmental factors play an important role in promoting or delaying its development. The identification of susceptibility genes and genetic variants for obesity requires various methodological approaches (Ichihara & Yamada, 2008). Although population genetic changes are too slow to be blamed for the rapid rise in obesity in the United States and many other countries, genes do play a role in the development of obesity. The origin of these genes, however, might not be recent. The “thrifty genotype” hypothesis states that any explanation of the obesity epidemic has to include both the role of genetics as well as that of the environment. A commonly quoted genetic explanation for the rapid rise in obesity is the mismatch between today’s environment and “energy-thrifty genes” that multiplied in the past under rather different environmental conditions. In other words, according to the “thrifty genotype” hypothesis

the same genes that helped our ancestors survive occasional famines are now being challenged by environments in which food is plentiful year round (cdc.gov/genomics, 2010).

Family and Social Factors

Family income and poverty status: A good understanding of the association between socioeconomic status (SES) and childhood obesity has numerous significant public health and policy implications including better prevention and management of this public health issue. Several studies have found that low socioeconomic status (SES) is associated with higher risk of obesity in certain populations (Baur, 1999; Booth, Macaskill, Lazarus, & Rao, 2006; Veugelers, 2005). Furthermore, Wang and Beydoun (2007) demonstrated that childhood obesity continues to be a leading public health concern that disproportionately affects low-income and minority children (Wang and Beydoun, 2007). Lutfiyya et al. (2008) found that overweight children were more likely to live in households with incomes below 150% of the Federal poverty level and concluded that poverty impacts childhood body mass index in at least two specific ways: unsafe neighborhoods and the cost and accessibility of healthy foods in low income communities (Lutfiyya, Garcia, Dankwa, Young, & Lipsky, 2008). The CDC has recently reported that during 1998 to 2008 the overall prevalence of obesity among low-income, preschool-aged children increased from 12.4% (n = 1,999,970) in 1998 to 14.5% (n = 1,967,625) in 2003 and 14.6% (n = 2,222,410) in 2008 (CDC, 2009). Obesity prevalence increased 0.43 percentage points annually during 1998--2003, but only 0.02 percentage points annually during 2003—2008 (CDC, 2009). Gundersen et al. (2008) found that younger children in food secure, low-income households in the United States who

experience higher levels of maternal stressors have a greater probability of being overweight than food insecure children (Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008). Wang and Zhang examined the changes in the association between overweight and family income between 1971 and 2002 and suggested the association between SES and overweight exists in complex patterns, and efforts solely targeting reductions in income disparities probably cannot effectively reduce racial disparities in obesity (Wang & Zhang, 2006). From a general standpoint the literature demonstrates that low-SES groups are more likely to have obesity than their high-SES counterparts in industrialized countries, but high-SES groups are at increased risk in developing countries (Sobal & Stunkard, 1989; Wang, 2001; Wang, Monteiro, & Popkin, 2002). In the United States several studies have shown that low-SES and minority groups have a higher prevalence of obesity (Flegal, Carroll, Ogden, & Johnson, 2002; Ogden, Flegal, Carroll, & Johnson, 2002; Paeratakul, Lovejoy, Ryan, & Bray, 2002; Wang, 2001; Wang, Monteiro, & Popkin, 2002). According to the National Center for Health Statistics of 1998 (National Center for Health Statistics, 1998) during 1963-1965 only 1.7% of black boys were overweight, but that rate has grown almost 10 times to reach 15.1% in 1988-1994. By 1988-1994 18.8% of Mexican American boys, 17.4% of black girls, and 11.7% of white girls were overweight. However, there have been some latest controversial arguments, for example Gordon-Larsen et al. (Gordon-Larsen, Adair, & Popkin, 2003) reported considerable ethnic disparity in the prevalence of overweight by SES, but only in girls was there a clear inverse association between SES and obesity.

Maternal employment: In the United States employment rates for married women with children under six rose from 19% in 1960 to 60% in 2005 (US Census Bureau.

2007), and in the United Kingdom the economic activity rate for women aged 16–59 rose from 59% in 1971 to 74% in 2007 (Labor Force Survey, ONS. 2007). Several recent studies emphasized the effect of average weekly work hours over the child's life on its overweight status, for example Anderson et al. (2003) and Ruhm (2004) suggested consistent evidence of a positive relationship between maternal employment and children's overweight. According to Anderson and colleagues (Anderson, Butcher, & Levine, 2003) there were two variables indicating the employment status, average hours worked per week during the weeks worked and duration of employment. The first indicator was calculated by averaging the hours of employment during the weeks worked at the current position at each contact. The second indicator was calculated by adding together the months worked at the current position at each contact; however, mothers' intensity or duration of employment may have been under- or over-estimated because of a change in employment status between the two contacts (Hawkins, Cole, Law, & the Millennium Cohort Study Child Health Group, 2008). These statements may be true because parents who work outside the home may affect children's eating patterns and level of physical activity. Some potential reasons are as following: parents who work outside may provide more fast food with high calorie rather than well cooked food because of limited time at home, for example Nock and Kingston (1988) and Bianchi (2000) suggested that employed mothers had less time for housework and home making because of increased working time outside. The definition of house work was defined by Nock and Kingston (1988) as several activities including meal preparation. Compared to mothers who stay at home without employment, employed mothers probably spend less time preparing meals because of time limitation and decreased energy levels (Stephanie

Von Hinke Kessler Scholder, 2008); children without parents at home after school may have limited choice to access healthy food. Klesges et al. (1991) stated that unsupervised children were more likely to choose unhealthy, highly caloric foods with low nutritional value. Children hardly ever eat food cooked by themselves, but just eat the food parents leave for them at home. However, those foods are mainly bought away from home by parents. Lin et al. (1996, 1999) (Lin B-H, Guthrie, & Blaylock, 1996; Lin B-H, Guthrie, & Frazao, 1999) found that food obtained away from home has more calories and (saturated) fats. In addition, Rolls et al. (2004) showed that restaurant and fast food meals had increased in size that induce more eating; and children may have more time spending at home without parents because of safety concerns, which means they may have more time watching TV, playing internet games, and less physical activity outside. However, Johnson et al. (1992) found no significant association between maternal employment and nutrient intake during 1987–1988 among children age 2–5 years old in the United States.

Family Structure: According to the United States Census Bureau (2006) 19% of all U.S. children lived in single-parent, female-headed households (U.S. Census Bureau, 2006). Changing patterns of family life associated with single-parent households or both parents working have been suggested to be partially responsible for the rising prevalence of overweight in children (Hawkins, Cole, Law, & the Millennium Cohort Study Child Health Group, 2008). Gibson et al. (2007) provided the evidence that children were more likely to be overweight or obese in the single-parent (single-mother) family structure.

Additionally, Duncan and Brooks-Gunn (1997) showed that single-mother family structure was an independent risk factor for behavior problems in children after adjustment of income (Duncan & Brooks-Gunn, 1997). These behavioral problems

among children may contribute to higher prevalence of overweight and obesity. Several risk factors such as economic hardship (McLoyd, 1998) and single-parent family structure (Shaw, Winslow, & Flanagan, 1999) could cause children behavior problems that may be associated with overweight or obesity issue. Because of less support from partner, single-parent structure family may spend more working time outside for increased income level to support the children, leading to a set of related problems including child development and mental problems. For example Lipman et al. (2002) suggested that maternal depression and hostile parenting were associated with psychiatric and social problems of children in both single-mother and two-parent families. Brown and Moran (1997) showed that single mothers were twice as likely as were married mothers to experience the onset of depression. All this evidence demonstrates a healthy family structure might moderate numerous risk factors for obesity. Parents are known to be important in determining early eating and exercise habits, and their involvement is crucial to achieving positive child health outcomes (Jackson, Mannix, Faga, & McDonald, 2005).

Other Possible Risk Factors

Findings regarding gender and obesity are mixed, although some evidence suggests a somewhat higher risk of being overweight for boys than girls (Demerath, 2003; Liu, 2008). Modifiable risk factors have also been proposed, including frequent consumption of fast food and physical inactivity (Johnson, Mander, Jones, Emmett, & Jebb, 2008; Watts et al., 2004). In addition television viewing has emerged as an important correlate of pediatric obesity, with one study identifying a fourfold risk of becoming overweight for children who watch 5 hours or more of television per day,

compared with those who watch 2 hours or less (Gortmaker, Must, Peterson, Coldritz, & Dietz, 1996; Robinson, 1999). Insufficient physical activity and poor nutrition are widely acknowledged as the primary mechanisms underlying the rise in excess body weight (Nicklas & Johnson, 2004). Recent studies have described geographic and socioeconomic gradients and identified aspects of children's lifestyle including physical and sedentary activities as risk factors for overweight and obesity (Canning, Courage & Frizzell, 2004; Graf et al., 2004; Hancox, Milne, & Poulton, 2004; Katzmarzyk & Ardern, 2004; Lamerz et al., 2005; Power et al., 2005; Tremblay & Willms, 2003; Willms, 2004). Most recently Swinburn and colleagues identified risk factors related to parents, family and school as potentially significant and as requiring more evidence so that evidence-based policy and program decision-making for the prevention of excess weight can be developed (Swinburn, Gill, & Kumanyika, 2005).

CHAPTER 3

DESIGN AND METHODS

Data Source and Study Sample

The NICHD Study of Early Child Care (SECC) is one of the most comprehensive longitudinal studies of children initiated by The National Institute of Child Health and Human Development (NICHD) in 1989. Participants in the NICHD SECCYD were recruited from hospitals at 10 research sites that were located in 10 different states. A conditionally random sample of 3,015 was selected from the eligible list to assure representation of at least 10% of single-parent households, mothers with less than a high school education, and ethnic minority mothers. Additional screening was conducted to exclude families planning to move within the next 3 years and infants who had stayed in the hospital for more than 1 week after birth. A total of 1,526 mothers were eligible and agreed to the 1-month interview; 1,364 of these mothers completed the 1-month interview and were enrolled in the study.

Recruitment began in January 1991 and was completed in November 1991. Participants were selected in accordance with a conditionally random sampling plan, which was designed to ensure that the recruited families (a) included mothers who planned to work or to go to school full time (60%) or part time (20%) in the child's first year, as well as some who planned to stay at home with the child (20%), and (b) reflected the demographic diversity (economic, educational, and ethnic) of the sites. Both two-parent and single-parent families were included. The major exclusionary criteria used were (a) mothers younger than 18 years of age at the time of the child's birth, (b) families who did not anticipate remaining in the catchment area for at least 3 years, (c) children

with obvious disabilities at birth or who remained in the hospital more than 7 days postpartum, and (d) mothers not sufficiently conversant in English.

Beginning with the time of enrollment (the 1-month home visit), families were scheduled for extensive periodic data collections. Over the 36-month period of Phase I of the study, each child was visited from the sites including his or her home, in child care (if used), and in a laboratory playroom. Phase I of the study was conducted from 1991-1994, following the children from birth to age 3 years. Phase II of the study was conducted from 1995 to 2000 to follow the 1,226 children continuing to participate from age 3 through their second year in school. Phase III of the study was conducted between 2000 and 2005 to follow over 1,100 of the children through their seventh year in school.

Study Variables

The outcome variables and exposure variables are described and analyzed as presented in Table 2.

Table 2
Study Variables

Outcome variables	Exposure variables	Covariates	
BMI percentile	Family income level/Poverty Status	Maternal education	Maternal age
Overweight status	Maternal employment	Child's birth weight	Child gender
	Family Structure/Marital Status		Child's ethnicity

Outcome Variables

BMI Percentile and Overweight and Obesity Status. Heights and weights assessed when children were 54 months old and at Grade 1 are used in this study. BMI percentile is defined according to the Centers for Disease Control and Prevention's age and gender specific growth charts. Body weight status in this study is defined under three categories: normal weight (BMI percentile < 85th percentile), overweight (BMI \geq 85th percentile and < 95th percentile), and obesity (BMI \geq 95th percentile).

Exposure Variables

Poverty Status. Family income level was measured as the ratio of income to needs, calculated as the total family income divided by the poverty threshold for family size. If the ratio of income to needs was less than 1, the household was considered under poverty line. If the ratio was greater than or equal to 1, the household was considered above poverty line. Poverty status assessed at children ages of 24 and 54 months were used in this study. In addition the transitions in poverty status are defined using the combinations of poverty status assessed at the two time points. Specifically, four types of transition are defined from 24 months to 54 months: a) above poverty line to under poverty line, b) under poverty line at both time points, c) above poverty line at both time points, and d) under poverty line to above poverty line.

Maternal Employment Status. Maternal employment status was collected through mother's self-report about the number of hours at work. For convenient comparison, maternal employment status was categorized into the two groups: not employed and employed.

Maternal working hours is also defined. This variable indicated the hours per week that the mother works at all jobs. If mother's employment status indicated that she was working, then the hours per week mother spent at work equaled the sum of the hours per week spent at each job. If mother indicated that she was not working or that she was on leave, then the hours of her working was set to 0. For convenient comparison the variable was changed into three categories: less than 10 hours, 10-30 hours, and greater than 30 hours per week. Maternal employment at child 24 and 54 months were used in this study. In addition, four categories are created to indicate the transitions in maternal employment status from child 24 to 54 months: a) not employed at both time points, b) from employed to not employed, c) from not employed to employed and, d) employed at both time points.

Family Structure/Marital Status. Maternal marital status in NICHD SECCYD includes 1) married, living together, 2) partnered, living together, 3) separated, not living together, 4) divorced, not living together, 5) widowed, 6) never married, not living together, 7) never married, not living together, no longer involved, 8) other. In this study, marital status was defined as four groups for convenient analysis after regrouping the eight categories: 1) married, living together, 2) partnered, living together, 3) separated, not living together, divorced, not living together, or widowed, and 4) never married, not living together. Maternal marital status at child 24 and 54 months are used in the current study. To examine the effects of change of marital status from children 24 months to 54 months on childhood overweight and obesity on 54 months and grade 3, eight categories are grouped: 1) from married (living together) to married (living together), 2) from partner (living together) to partner (living together), 3) from separated, divorced, not

living together, or widowed to separated, divorced, not living together, or widowed, 4) from never married (not living together) to never married (not living together), 5) from partner (living together) to married (living together), 6) from not living together to living together, 7) from married or partner, living together to separated, divorced, not living together, or widowed, 8) others.

Covariates

Maternal Education. Maternal education was categorized into less high school, high school grad or GED, some college but no degree, AA degree or vocational school beyond high school, bachelor's degree from college or university, some graduate work or a master's degree, law degree (LL.B or J.D.), and more than one master's degree or a doctoral degree (M.D., Ph.D., Ed.D., etc.).

Child's Birth Weight. Child's birth weight was obtained from medical charts review.

Other Variables

Information of mothers' age, ethnicity, and child gender was obtained at the first month assessment after birth.

Data Analysis

Data Preparation

Data were obtained from Phase I, II, and III of the NICHD SECCYD. Documentations includes: descriptions of instruments used to gather the raw data; descriptions of how summary variables were computed and psychometric properties of these variables, extensive documentation of study procedures, data collection forms, and a full variable dictionary, linking each variable to the source form, and to the data set where it can be found. Information on the study variables is available in different files. Review of the documentations and merging of the data files were performed and a working data file that had all variables of interest was created.

Descriptive and Bivariate Analysis

Descriptive statistics (including mean, standard deviation, median, percentage) were used as appropriate to describe overweight status at different time points. The descriptive and bivariate statistics were used to describe the overweight status (prevalence of overweight and obesity or BMI percentile) for the study sample as a whole and for the subgroups categorized by maternal marital status, maternal employment, and poverty status,. Bivariate analyses including Analysis of Variance and Chi-square test were used

Multivariable Models

Multiple logistic regression analysis was used to assess the relationship between family income, parental marital status, maternal employment, and overweight status after adjusting covariates. The odds ratios (and 95% confidence intervals) of overweight for the different potential risk factors were obtained from the logistic regression model to

measure the associations with the adjustment of multivariate covariates. Multiple linear regressions were used to analyze the exposure factors with BMI percentile as the dependent variable. These covariates including child's sex, ethnicity, birth weight, maternal educational level, and maternal age at birth were analyzed as potential confounders. All analyses were performed using SPSS version 17.

CHAPTER 4

RESULTS

The characteristics of children who participated in the study were described in Table 3. 60.8% of mothers were 25-34 years old. Most of mothers and children were whites, and blacks counted for 12.1%. Only 1.6% mothers had more than one master's degree or a doctoral degree (M.D., Ph.D., Ed.D., etc.), about 20.2% had high school education, 34.0% had some college but no degree beyond high school, 22.1% had bachelor's degree, and 12.6% had some graduate work or a master degree. More than four fifths of child's birth weight was normal.

Table 3

Characteristics of The Participants: Information Attained at 1 Month After Birth

Characteristic	Participants	
	n	Proportion (%)
Maternal Age		
18-24	298	25.5
25-34	711	60.8
35-46	160	13.7
Maternal Ethnicity		
Blacks	141	12.1
Whites	977	83.6
Others	51	4.4
Mother's Education Level		
Less than high school	100	8.6
High school grad or GED	236	20.2
Some college but no degree,	397	34.0
AA degree or vocational school beyond high school		
Bachelor's degree from college or university	258	22.1
Some graduate work or a master's degree	147	12.6
Law degree (LL.B or J.D.)	12	1.0
More than one master's degree or a doctoral degree (M.D., Ph.D., Ed.D., etc.)	19	1.6
Child Gender		

Table 3 (Continued)

Characteristic	Participants	
	n	Proportion (%)
Male	594	50.8
Female	575	49.2
Child Ethnicity		
Blacks	141	12.1
Whites	953	81.5
Others	75	6.4
Birth Weight Status (grams)		
<2500	22	2.2
2500-3499	488	49.2
3500-3999	336	33.9
>4000	145	14.6

Table 4 describes the exposure variables assessed at children 24 and 54 months old. Approximately 73.8% mothers lived above the poverty line. About two thirds mothers were employed, 37.9% mothers worked greater than 30 hours per week. With regard to marital status, about seven tenths of mothers got married and lived with their husbands. When children were 54 months old the percent of mothers employed slightly decreased to 57.7%. In addition the percent of mothers who got married and lived together decreased to about 61.2%.

Table 4

Description of Exposure Variables Assessed at Children 24 and 54 Months Old

Exposure variables	24 months	54 months
	n(%)	n(%)
Maternal Employment		
Not employed	382(28.0)	297(21.8)
Employed	824(60.4)	787(57.7)
Maternal Status		
Married, living together	932(68.3)	835(61.2)
Partnered, living together	100(7.3)	69(5.1)
Separated, not living together, divorced, not living together, or widowed	47(3.5)	85(6.2)
Never married, not living together	118(8.6)	95(7.0)

Table 4 (continued)

Exposure variables	24 months	54 months
	n(%)	n(%)
Poverty status		
Under poverty line	183(13.4)	127(9.3)
Above poverty line	1007(73.8)	946(69.3)
Work Hours		
Less than 10 hours	450(33.0)	381(27.9)
10-30 hours	238(17.4)	227(16.6)
>30 hours per week	518(37.9)	475(34.8)

Overweight and obesity status was assessed at different times of child development (Table 5). The prevalence of obesity was 7.0% at 54 months and 11.5% at grade 3.

Table 5

Overweight and Obesity Status at Different Times of Child Development

Overweight status	54 months	Grade 3
	n(%)	n(%)
Normal weight	776(56.9)	645(47.2)
Overweight	159(11.6)	136(10.0)
Obesity	96(7.0)	157(11.5)

Prevalence of overweight and obesity at children 54 months and grade 3 are shown by exposure status assessed at children 24 months old (Table 6). The prevalence of overweight and obesity was higher in families under poverty line than the families above poverty line at grade 3.

Table 6

Prevalence of Overweight and Obesity at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 24 Months Old

Exposure variables	54 months		p	Grade 3		p
	Overweight n(%)	Obesity n(%)		Overweight n(%)	Obesity n(%)	
Maternal Employment						
Not employed	52(16.8)	30(9.7)		46(17.0)	47(17.4)	
Employed	104(14.8)	66 (9.4)		86 (13.4)	107(16.6)	

Table 6 (continued)

Exposure variables	54 months		p	Grade 3		p
	Overweight n(%)	Obesity n(%)		Overweight n(%)	Obesity n(%)	
Maternal Marital Status						
Married, living together	118(14.9)	72(9.1)		97(13.7)	113(16.0)	
Partnered, living together	16(18.8)	6(7.1)		15(20.0)	14(18.7)	
Separated, not living together, divorced, not living together, or widowed	8(53.9)	3(8.8)		4(13.3)	7(23.3)	
Never married, not living together	11(12.2)	14(15.6)		15(16.5)	21(23.1)	
Poverty Status						
Table 6 (continued)						
Under poverty line	22(15.1)	20(13.7)		28(21.2)	30(22.7)	
Above poverty line	131(15.3)	76(8.8)		102(13.2)	123(15.9)	
Work Hours						
Less than 10 hours	59(15.8)	37(9.9)		58(17.9)	54(16.7)	
10-30 hours	28(13.9)	16(8.0)		23(12.9)	26(14.6)	
>30 hours per week	69(15.6)	43(9.8)		51(12.4)	74(18.0)	

*Group comparison is significant at the 0.05 level (2-tailed).

Table 7 shows the prevalence of overweight and obesity at children 54 months and grade 3 by exposure status assessed at children 54 months old.

Table 7

Prevalence of Overweight and Obesity at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 54 Months Old

Exposure variables	54 months		p	Grade 3		p
	Overweight n(%)	Obesity n(%)		Overweight n(%)	Obesity n(%)	
Maternal Employment						
Not employed	45(16.2)	30(10.8)		33(14.4)	39(17.0)	
Employed	112 (15.1)	65(8.7)		96(14.5)	109(16.5)	
Maternal Marital Status						
Married, living together	115(14.6)	74(9.4)		90(13.1)	116(16.9)	
Partnered, living together	10(16.1)	3(4.8)		12(22.2)	7(13.0)	
Separated, not living together, divorced, not living together, or widowed	18(23.4)	6(7.8)		13(18.8)	8(11.6)	
Never married, not living together	14(15.6)	12(13.3)		14(18.2)	17(22.1)	
Poverty status						

Table 7 (continued)

Exposure variables	54 months			Grade 3		
	Overweight n(%)	Obesity n(%)	p	Overweight n(%)	Obesity n(%)	p
54 months						
Under poverty line	19(16.2)	15(12.8)		16(16.5)	19(19.6)	
Above poverty line	135(15.1)	80(8.9)		111(14.2)	127(16.2)	
Work Hours						
Less than 10 hours	58(16.3)	33(9.3)		40(13.5)	46(15.5)	
10-30 hours	33(15.1)	20(9.2)		24(12.7)	30(15.9)	
>30 hours per week	66(14.8)	23(9.4)		65(16.1)	72(17.8)	

*Group comparison is significant at the 0.05 level (2-tailed).

The mean BMI percentiles are compared across each exposure variables with exposure status assessed at children 24 months old (Table 8). The mean BMI percentiles were highest among children with parents who were never married and not living together at children grade 3. Additionally, mean BMI percentiles were higher for families under poverty line than families above poverty line at both time points.

Table 8

BMI Percentile at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 24 Months Old

Exposure variables	54 months				Grade 3			
	n	mean	S D	p	n	mean	S D	p
24 months								
Maternal Employment								
Not employed	310	61.2	28.3		270	67.9	26.4	
Employed	705	60.7	27.0		643	63.4	28.5	
Maternal Marital Status								*
Married, living together	794	59.7	27.8		707	63.4	28.3	
Partnered, living together	85	61.4	27.2		75	66.5	30.0	
Separated, not living together	38	67.6	23.0		33	70.5	23.5	
Never married, not living together	90	66.8	24.4		91	71.3	25.2	
Poverty status				*				*
Under poverty line	146	66.7	25.3		132	74.8	23.0	
Above poverty line	859	60.0	27.5		772	63.1	28.2	
Work Hours								
Less than 10 hours	373	61.6	27.6		324	67.4	26.7	
10-30 hours	201	58.9	26.7		178	61.6	28.8	
>30 hours per week	441	61.2	27.5		411	64.0	28.4	

*Group comparison is significant at the 0.05 level (2-tailed).

In Table 9 BMI percentile at children 54 months and grade 3 were compared by exposure status assessed at children 54 months old. The mean BMI percentiles at grade 3 were highest for parents who was never married and not living together among the groups of maternal marital status.

Table 9
BMI Percentile at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 54 Months Old

	54 months				Grade 3			
	n	mean	S D	p	n	mean	S D	p
Maternal Employment								
Not employed	277	61.2	28.3		229	66.4	26.6	
Employed	744	60.8	27.0		661	64.0	28.4	
Maternal Marital Status								
Married, living together	790	60.1	27.9		688	63.2	28.4	
Table 9 (continued)								
Partnered, living together	62	59.0	26.8		54	64.8	29.0	
Separated, not living together	79	62.5	27.0		71	67.8	26.0	
Never married, not living together	90	68.0	22.6		77	73.7	22.5	
Poverty status								
Under poverty line	117	65.4	25.7		97	68.6	26.2	
Above poverty line	895	60.3	27.5		783	64.1	28.0	
Work Hours								
Less than 10 hours	355	60.8	27.5		296	64.5	27.1	
10-30 hours	218	60.8	28.6		189	62.6	28.4	
>30 hours per week	447	61.1	26.6		404	65.7	28.3	

*Group comparison is significant at the 0.05 level (2-tailed).

The prevalence of overweight and obesity at children 54 months and grade 3 are shown by combined exposure status assessed at children 24 months and 54 months old (Table 10). Statistical significance of difference in the prevalence was not found in comparison of the different categories of an exposure.

Table 10
Prevalence of Overweight and Obesity at Children 54 Months and Grade 3 by Combined Exposure Status Assessed at Children 24 Months and 54 Months Old

Exposure variables 24 months→54 months	54 months		p	Grade 3		p
	Overweight	Obesity		Overweight	Obesity	

Table 10 (continued)

	n(%)	n(%)	n(%)	n(%)
Family income status				
Above poverty line → Under poverty line	5(19.2)	3(11.5)	2(10.5)	3(15.8)
Under poverty line → Under poverty line	12(15.0)	12(15.0)	14(19.4)	15(20.8)
Above poverty line → Above poverty line	124(15.1)	72(8.7)	97(13.4)	115(15.9)
Under poverty line → Above poverty line	8(13.6)	8(13.6)	11(22.0)	12(24.0)
Employment status				
Not employed → Not employed	29(16.0)	21(11.6)	20(13.4)	27(18.1)
Employed → Not employed	15(16.5)	9(9.9)	13(16.5)	12(15.2)
Not employed → Employed	22(17.5)	9(7.1)	23(20.9)	16(14.5)
Employed → Employed	88(14.5)	56(9.2)	71(13.0)	92(16.9)
Marital Status				
Married, living together → Married, living together	107(14.6)	69(9.4)	85(13.2)	108(16.8)
Partner, living together → Partner, living together	6(17.6)	2(5.9)	6(20.7)	5(17.2)
Separated, divorced, not living together, widowed → Separated, divorced, not living together, widowed	6(27.3)	3(13.6)	2(9.5)	6(28.6)
Never married, not living together → Never married, not living together	8(11.8)	11(16.2)	10(15.9)	14(22.2)
Partner, living together → Married, living together	4(14.8)	3(11.10)	8(8.7)	4(17.4)
Not living together → living together	4(13.3)	2(6.7)	4(15.4)	5(19.2)
Married or partner, living together → Separated, divorced, not living together, widowed	12(24.0)	2(4.0)	11(24.4)	1(2.2)
Others	4(12.5)	2(6.3)	6(21.4)	5(17.9)

Table 11 shows mean BMI percentiles at children 54 Months and grade 3 by combined exposure status assessed at children 24 months and 54 months. It was found that at children grade 3, among the groups of family income transition, the means of BMI percentile was highest when families became above poverty line from under poverty line and lowest when families were above poverty line all along.

Table 11

BMI Percentile at Children 54 Months and Grade 3 by Combined Exposure Status Assessed at Children 24 Months and 54 Months Old

Exposure variables	54 months				Grade 3			
	n	mean	S D	p	n	mean	S D	p
Family income status								
Above poverty line→ Under poverty line	26	65.8	26.6		19	64.7	28.7	*
Under poverty line→ Under poverty line	80	66.7	24.8		72	71.2	24.5	
Above poverty line→ Above poverty line	823	59.9	27.4		725	63.2	28.2	
Under poverty line→ Above poverty line	59	65.7	27.0		50	78.2	21.0	
Employment status								
Not employed→ Not employed	181	61.4	29.0		149	67.6	26.1	
Employed → Not employed	91	60.6	27.5		79	64.6	27.5	
Not employed→ Employed	126	61.1	27.3		110	67.0	27.3	
Table 11 (continued)								
Employed → Employed	608	60.6	27.0		545	63.3	28.6	
Marital Status								
Married, living together→ Married, living together	735	59.8	27.8		642	63.1	28.5	
Partner, living together→ Partner, living together	34	55.8	27.7		29	64.4	31.9	
Separated, divorced, not living together, widowed → Separated, divorced, not living together, widowed	22	71.5	24.2		21	70.4	26.0	
Never married, not living together→ Never married, not living together	68	67.7	23.6		63	72.6	23.2	
Partner, living together → Married, living together	27	63.9	29.8		23	58.1	32.4	
Not living together→ living together	30	67.2	20.8		26	72.9	21.2	
Married or partner, living together→ Separated, divorced, not living together, widowed	50	60.7	26.5		45	68.0	25.0	
Others	32	57.9	27.8		28	66.3	29.0	

*Group comparison is significant at the 0.05 level (2-tailed).

The associations of obesity status at children 54 months and grade 3 with exposure status assessed at children 24 months old was analyzed by logistic regression with adjustment for covariates (Table 12). It was found that child birth weight was

statistically significantly associated with obesity risk at both time points. Maternal education level had a negative association obesity risk at children grade 3. Children in families under poverty line were at a higher risk of overweight or obesity at grade 3 compared to children in families above poverty line.

Table 12
Logistic Regression: Obesity Status at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 24 Months Old

Exposure variables	54 months			G3		
	Estimate	Std. Error	p	Estimate	Std. Error	P
Maternal education	-.038	.037		-.073	.036	*
Mother work hours	.008	.007		.007	.006	
Maternal age						
18-24	-.046	.213		-.116	.204	
Table 12 (continued)						
35-46	-.212	.228		-.314	.230	
25-34	--	.		--	.	
Maternal employment status						
Not employed	.407	.273		.182	.268	
Employed	--	.		--	.	
Marital status						
Never married, not living together	.095	.319		-.076	.297	
Partnered, living together	.001	.293		.047	.282	
Separated, not living together	.167	.383		.037	.386	
Divorced, not living together						
Widowed						
Married, living together	--	.		--	.	
Poverty Status						
Under poverty line	.059	.278		.543	.264	*
Above poverty line	--	.		--	.	
Child race						
Blacks	.237	.270		.062	.254	
Other	.010	.328		.218	.298	
Whites	--	.		--	.	
Birth weight	.001	.000	*	.001	.000	*
Child gender						
Male	-.191	.150		.165	.146	
Female	--	.		--	.	

*Group comparison is significant at the 0.05 level (2-tailed).

--Reference group

The weight status at children 54 months and grade 3 by combined exposure status assessed at children 54 months old was analyzed by logistic regression. It was found in Table 13 that child birth weight was statistically significant with higher weight status at both assessment points. Maternal education had a negative association with weight status at child's grade 3. Children had a higher risk of being overweight or obese at children 54 months and grade 3 if mothers worked more hours. Children with mothers not employed compared to mothers employed were at a higher risk for overweight/obesity at both two time points.

Table 13
Logistic Regression: Weight Status at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 54 Months Old

Exposure variables	54 months			Grade 3		
	Estimate	Std. Error	p	Estimate	Std. Error	P
Maternal education	-.023	.037		-.089	.037	*
Mother work hours	.014	.006	*	.017	.006	*
Maternal age						
18-24	.010	.207		-.125	.200	
35-46	-.248	.229		-.324	.231	
25-34	--	.		--	.	
Maternal employment status						
Not employed	.758	.265	*	.564	.265	*
Employed	--	.		--	.	
Marital status						
Never married, not living together	.007	.323		.203	.315	
Partnered, living together	-.329	.351		-.063	.319	
Separated, not living together	.150	.281		-.340	.299	
Divorced, not living together						
Widowed						
Married, living together	--	.		--	.	
Poverty Status						
Under poverty line	-.194	.288		.034	.292	
Above poverty line	--	.		--	.	
Child race						
Blacks	.207	.262		.232	.253	
Other	-.025	.330		.025	.330	
Whites	--	.		--	.	

Table 13 (continued)

Exposure variables	54 months			Grade 3		
	Estimate	Std. Error	p	Estimate	Std. Error	P
Birth weight	.001	.000	*	.001	.000	*
Child gender						
Male	-.186	.150		.157	.148	
Female	--	.		--	.	

*Group comparison is significant at the 0.05 level (2-tailed).

--Reference group

BMI percentiles at children 54 months and grade 3 in relation with exposure status assessed at children 24 months old were analyzed by general linear regression with adjustment for covariates (Table 14). Children in families under poverty line were at a higher risk of overweight or obesity at grade 3 compared to children in families above poverty line. Children with mothers who were separated (not living together), divorced (not living together), or widowed tended to have a higher BMI percentile at grade 1 than children with mothers who were married (living together).

Table 14

Linear Regression: Weight Status at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 24 Months Old

Exposure variables	54 months			Grade 3		
	B	Std. Error	p	B	Std. Error	P
Maternal education	-.675	.4138		-.744	.4593	
Mother work hours	.087	.0717		.130	.0777	
Maternal age	-.111	.1857		-.067	.2035	
Maternal employment status						
Not employed	2.953	2.9849		6.543	3.2897	*
Employed	--	.		--	.	
Marital status						
Never married, not living together	3.557	3.6879		-.959	3.8799	
Partnered, living together	-.599	3.2773		-2.345	3.6253	
Separated, not living together, divorced, not living together, or widowed	6.007	4.4842		3.728	4.9588	
Married, living together	--	.		--	.	
Poverty status						
Under poverty line	3.715	3.1543		8.600	3.4381	*
Above poverty line	--	.		--	.	

Table 14 (continued)

Exposure variables	54 months			Grade 3		
	B	Std. Error	p	B	Std. Error	P
Child race						
Blacks	.258	3.0870		3.724	3.2682	
Other	2.391	3.6518		.626	3.8833	
Whites	--	.		--	.	
Birth weight	.013	.0017	*	.010	.0018	*
Child gender						
Male	-1.419	1.6782		2.399	1.8229	
Female	--	.		--	.	

*P<0.05

--Reference group

From Table 15, the weight status at children 54 months and grade 3 by exposure status assessed at children 54 months old was analyzed by general linear regression. It was found that child birth weight was statistically significant with higher weight status at both assessment points. The risk of overweight or obesity at grade 3 was higher among children with mothers who were unemployed compared to mothers who were employed. Mothers' work hours were also associated with a higher risk of childhood overweight or obesity at grade 3.

Table 15

Linear Regression: Weight Status at Children 54 Months and Grade 3 by Exposure Status Assessed at Children 54 Months Old

Exposure variables	54 months			G3		
	B	Std. Error	p	B	Std. Error	P
Maternal education	-.629	.4118		-.985	.4597	*
Mother work hours	.117	.0664		.168	.0722	*
Maternal age	-.216	.1828		-.091	.2011	
Maternal employment status						
Not employed	4.467	2.8440		8.219	3.1538	*
Employed	--	.		--	.	
Marital status						
Never married, not living together	4.566	3.7029		7.696	4.1085	
Partnered, living together	-2.674	3.6933		-.674	4.0415	
Separated, not living together, divorced, not living together, or widowed	.316	3.3058		2.371	3.5945	
Married, living together	--	.		--	.	

Table 15 (continued)

Exposure variables	54 months			G3		
	B	Std. Error	p	B	Std. Error	P
Poverty status						
Under poverty line	-1.787	3.3010		3.691	3.7189	
Above poverty line	--	.		--	.	
Child race						
Blacks	.283	2.9519		5.454	3.2334	
Other	-.175	3.6450		-1.735	4.0985	
Whites	--	.		--	.	
Birth weight	.013	.0017	*	.011	.0018	*
Child gender						
Male	-1.472	1.6679		2.117	1.8334	
Female	--	.		--	.	

* P<0.05

--Reference group

Overweight and obesity status at children 54 months and grade 3 in association with the combined exposure status assessed at the children 24 months and 54 months are analyzed by logistic regression with adjustment for covariates (Table 16). None of the key family exposure variables of our interest was significantly associated with the risk of overweight or obesity.

Table 16

Logistic Regression: Weight Status at Children 54 Months and Grade 3 by Combined Exposure Status Assessed at the Change from Children 24 Months to 54 Months

Exposure variables	54 months			G3		
	Estimate	Std. Error	p	Estimate	Std. Error	P
Birth weight	.001	.000	*	.001	.000	*
Maternal education	-.026	.038		-.079	.038	*
Child gender						
Male	-.175	.153		.176	.150	
Female	--	.		--	.	
Child race						
Blacks	.214	.279		.158	.266	
Other	.026	.334		.075	.335	
Whites	--	.		--	.	
Maternal employment change status						
Not employed → Not employed	.343	.211		-.045	.221	
Employed → Not employed	.219	.269		.033	.267	
Not employed → Employed	-.001	.249		-.073	.241	
Employed → Employed	--	.		--	.	
Maternal poverty change status						

Table 16 (continued)

Exposure variables	54 months			G3		
	Estimate	Std. Error	p	Estimate	Std. Error	P
Above poverty line → Under poverty line	.425	.504		-.241	.576	
Under poverty line → Under poverty line	.179	.359		.379	.357	
Under poverty line → Above poverty line	.144	.349		.585	.328	
Above poverty line → Above poverty line	--	.		--	.	
Marital status change						
Others	-.525	.535		.241	.458	
Partner, living together → Partner, living together	-.136	.439		.032	.415	
Separated, divorced, not living together, widowed → Separated, divorced, not living together, widowed	.710	.452		.303	.464	
Never married, not living together → Never married, not living together	.029	.371		-.099	.362	
Partner, living together → Married, living together	.041	.463		-.327	.491	
Not living together → living together	-.418	.496		-.160	.444	
Married or partner, living together → Separated, divorced, not living together, widowed	.096	.351		-.544	.387	
Married, living together → Married, living together	--	.		--	.	
Table 16 (continued)						
living together						
Maternal age						
18-24	.007	.217		-.123	.213	
35-46	-.249	.229		-.320	.231	
25-34	--	.		--	.	

*Group comparison is significant at the 0.05 level (2-tailed).

--Reference group

In Table 17 BMI percentiles at children 54 months and grade 3 in relation with the combined exposure status assessed at children 24 months and 54 months are analyzed by general linear regression. Children in families that changed from under poverty line to

above poverty line had a higher BMI percentile on average at children grade 3 than children in families that were always above poverty line.

Table 17
Linear Regression: Weight Status at Children 54 Months and Grade 3 by Combined Exposure Status Assessed at the Change from Children 24 Months to 54 Months

Exposure variables	54 months			G3		
	B	Stan error	p	B	Stan error	p
Child gender						
Male	-1.404	1.6980		2.213	1.8654	
Female	--	.		--	.	
Child race						
Blacks	.404	3.1316		4.185	3.3963	
Other	1.893	3.7247		-1.389	4.1741	
Whites	--	.		--	.	
Birth weight	.013	.0017	*	.010	.0018	*
Maternal education	-.519	.4242		-.767	.4725	
Maternal age	-.162	.1884		-.057	.2095	
Poverty status change						
Above poverty line → Under poverty line	8.368	5.8527		-.951	6.9338	
Under poverty line → Under poverty line	2.726	4.1082		.919	4.5809	
Under poverty line → Above poverty line	5.156	3.9840		10.050	4.4062	*
Above poverty line → Above poverty line	--	.		--	.	
Marital status change						
Others	-4.604	5.5164		3.742	6.0431	
Partner, living together → Partner, living together	-6.167	4.8196		-2.662	5.3647	
Table 17 (continued)						
Separated, divorced, not living together, widowed → Separated, divorced, not living together, widowed	9.904	5.7927		5.406	6.1530	
Never married, not living together → Never married, not living together	4.222	4.2269		3.726	4.6583	
Partner, living together → Married, living together	1.876	5.2637		-7.859	5.8859	
Partner not living together → partner living together	4.622	5.1059		4.805	5.6526	
Married or partner, living together → Separated, divorced, not living together, widowed	-1.157	4.0034		2.815	4.3500	

Table 17 (continued)

Exposure variables	54 months			G3		
	B	Stan error	p	B	Stan error	p
Married, living together → Married, living together	--	.		--	.	
Maternal employment status change						
Not employed → Not employed	1.496	2.4121		4.300	2.7322	
Employed → Not employed	.294	3.0277		1.541	3.3191	
Not employed → Employed	-.324	2.7376		1.087	3.0186	
Employed → Employed	--	.		--	.	

*Group comparison is significant at the 0.05 level (2-tailed).

--Reference group

CHAPTER 5

DISCUSSION

Summary of Findings

This study investigated the dynamics of three key family contextual variables - family poverty status, maternal employment, and maternal marital status in association with the development of childhood overweight and obesity. Major findings include: 1) children in families with incomes below poverty line at child's 24 or 54 months of age were at a higher risk of becoming overweight and obese at child's third grade than children in families with incomes above the poverty line; 2) longer maternal working hours at child's 54 months of age was associated with an increased risk of overweight and obesity at child's third grade; 3) BMI percentile at the third grade were higher on average among children in families with incomes below poverty line than in families with incomes above poverty line when poverty status at either of the two time points was analyzed ; 4) compared to maternal unemployment, maternal employment at child's 24 or 54 months old was associated with a higher mean BMI percentile at child's 3rd grade, while longer maternal working hours at child's 54 months of age was associated with a higher BMI percentile at child's third grade; 5) when the transition of family status from child's 24 months to 54 months of age was analyzed, children with family incomes below poverty line at child's 24 months to above poverty line at child's 54 months tended on average to have a higher BMI percentile at child's grade three than children with other patterns of transition in family poverty status from child's 24 to 54 months.

Energy-dense foods such as those based on refined grains, added sugar and added fats are cheaper than lean meats, fish, and fresh fruits and vegetables, and low-income

families may have more difficulties in adopting healthier diet. Single-parent household and longer maternal working hours are thought to be associated with a greater reliance on pre-prepared or 'fast-food' meals and less time and attention available for supervising young children in eating or outdoor physical activity. However, the associations of these factors with childhood overweight were not consistent from different studies. In developed countries childhood obesity tends to follow the typical health inequalities gradient and is more prevalent in low income households (Wake et al., 2006) and (Wang et al., 2002). One cross-sectional study conducted by Voss (2008) found that social inequality appeared to have little impact on physical activity in young children. Lee (2009) found a significant effect of poverty in childhood on obesity outcomes for females but not for males. Murasko (2009) investigated interactive effects of family socioeconomic status (SES) on child obesity and suggested that obesity was inversely related to family SES as measured by poverty status. Early childhood poverty could lead to adult obesity. Ziol-Gues (2009) found that mean annual family incomes averaged less than \$25,000 was significantly associated with increased adult body mass index, suggesting economic conditions in the early period of life may play an important role in eventual anthropometric measures. Olson, Bove, and Miller, (2007) suggested that poverty-associated food deprivation might be the reason for the relationship between low SES in early childhood and obesity in later phases of development. Interestingly, this study indicated that when family income level changed from below poverty line to above poverty line, children tended to become heavier, in reference to other forms of transition in family poverty status. This may be because, food deprivation in childhood might change the attitude and behaviors toward food, and after the period of deprivation of food, child

might be excited to become overeating because of the availability of food and to meet emotional needs.

The number of mothers who work outside of the home increased from 38% in 1970 to 64% in 2000 (Institute of Medicine, 2005). There were a limited number of studies examined the association of maternal employment with childhood weight status. Takahashi et al. (1999) found that there was a positive relationship between mothers' employment and childhood overweight among 3-year-old Japanese children. But Johnson et al. (1992) found that there was not a significant effect of maternal employment on nutrient intake using the sample of US children age 2–5 in 1987–1988. Anderson et al. (2003) and Ruhm (2004) found that mothers' full-time work was more strongly associated with excess child weight in high income households than in others. However, high income families also had the lowest overall prevalence of obesity so that even when mothers worked full-time the prevalence of overweight in their children was still lower than the prevalence for the lowest income households, irrespective of maternal work hours in these families (Anderson et al., 2003).

The possible higher risk of childhood obesity associated with maternal employment/working hours has been well discussed. Anderson et al., (2003), Fertig et al., (2006), Hawkins et al., (2007) Phipps et al., (2006), and Cawley & Liu, (2007) claimed compared to unemployed mothers employed mothers have less time for preparing meals, purchase more pre-prepared foods and are less likely to eat with their children. Thus, children may be more exposed to unmonitored poor nutritional quality. Cutler, Glaeser, & Shapiro (2003) indicated that maternal employment may also result in late mealtimes, leading to more snacking by family members, with consequential elevated risks for

weight gain. Another mechanism links to what children eat and how they spend their time. Employed mothers have less time to monitor their children's eating outside of mealtimes, and children make less healthy food choices when unsupervised (Klesges, Stein, Eck, Isbell, & Klesges, 1991). In addition children of employed mothers may also spend more time watching television and less time being physically active. When at home without parental supervision, children may be more likely to enjoy screen-based entertainment over more active pastimes, and parents may restrict outdoor activity for safety reasons. This study found that maternal working hours were associated with a higher risk and BMI percentile, which are consistent with the possible mechanisms discussed above. In this study we were able to assess the effects of maternal employment status and maternal working hours simultaneously. We found that with the adjustment for maternal working hours compared to maternal unemployment, maternal employment was associated with a lower risk and BMI percentile among children. It is possible that mothers' contributions to household income enables the purchase of more healthy foods and participation in structured sports, bringing health benefits (Hofferth & Curtin, 2005). Therefore, some adverse effects of mothers' working hours on children's weight may be offset by gains in household income in some families.

Many transformations have occurred in American family life over the past 30 years including shifts in women's roles, delayed marriage, extramarital childbearing, increased rate of divorce, single parenthood, and changes in work status of parents (National Research Council (NRC), 2003). The marital status may play a significant role on impacting the quality and quantity of taking care children because worse marriage can lead to stress, lack of support, deficient time monitoring the children. In this study we

found a significant association between maternal marital status and childhood weight status in the bivariate analysis but not in the multiple variables analysis adjusting for family poverty status, maternal employment, maternal education level, and other covariates, suggesting that family income level, maternal employment, education, etc. might mediate the effect of marital status.

Strengths of the Study

The current study has several strengths. First, a large number of families from 10 different states in the United States participated in the study. Therefore, the findings may have good external validity. Second, longitudinal data were used and family poverty status, maternal employment, and maternal marital status at different time points in relation with weight status at later times were assessed, providing information on the dynamics of the family contexts in relation to the development of childhood obesity.

Limitations of the Study

This study also has several limitations. Useful information on dietary intake and physical activity was not available from the data we had, and we were thus not able to explore more proximate “causes” in the pathways to the development of childhood obesity. In the next step of our study we will fully take advantage of the longitudinal data set and use more complicated approaches such as hierarchical linear model to further evaluate the roles of these key family factors in the development of childhood obesity.

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APPENDIX

Variables Pooled from NICHD Database

Family total income.....	TINCAMXX
Poor status	POORMXX
Maternal Ethnicity.....	MRACEMXX
Maternal Age	MAGEMXX
Maternal Employment	MEMPSMXX
Maternal Education	MEDUCMXX
Marital Status	MSTATMXX
Child Ethnicity.....	CRACEM01
Child's Gender	CSEX-M01
Baby birth weight in grams.....	BWTGM00
Maternal marital status.....	MSTATXX
Hours of mother works for all jobs.....	MHRW_M
BMI percentile.....	BMIPCT

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