ESSAYS ON DETERMINANTS OF CHILDREN'S WEIGHT CHANGES IN CHINA

by

Ruizhi Xie

A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics

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ABSTRACT

In recent decades, China has started to exhibit some of the children's weight problems commonly seen in more developed countries. This study addresses Chinese children's weight changes from two perspectives, using China Health and Nutrition Survey (CHNS) data from 1991-2011. The first essay focuses on the impact of socio-economics status (SES) on children's weight changes and how the SES-weight gradient differs with age, gender and urban status. I find that the child's weight is positively correlated to SES, but the impact of SES diminishes with age. The rise of childhood obesity, especially in urban areas and among high SES families, might be attributed to globalization beginning in the 2000s, which modifies the culture of calorie intake and energy expenditure.

The second essay examines the intergenerational transmission of weight from parents to children. I find that low SES families have a stronger intergenerational persistence of weight, which suggests their inability to alter children's weight through nurturing. I also find that parents' weights are an important predictor of children's weight after controlling for demographics, SES and living environment. A Blinder-Oaxaca decomposition analysis suggests that more than half of the difference in children's BMI ranking between urban and rural areas is attributable to the different urban-rural endowments.

Chapter 1

INTRODUCTION

In recent decades, China has started to exhibit some of the children's weight problems commonly seen in more developed countries. Chinese children have experienced larger increase in Body Mass Index (BMI) compared with their peers in the U.S. and U.K. (Ji and Chen 2013). In 2010, the overall prevalence for overweight status was 9.9% while for obesity, the rate was 5.1% for Chinese children (Ji and Chen 2013). Notably, children who are obese have a 25-50% probability of progressing to obesity when they grow up, and obesity might have many immediate and long-term effects on health status and well-being in a negative way (Li 2013). Obesity is widely recognized as a risk factor for coronary heart disease, diabetes, hypertension, high cholesterol, asthma and many other health issues. And there is little debate that obesity is correlated with increased morbidity, impaired quality of life and a high health care cost.

The scenario becomes so worrying that some researchers have already started to document the increase in children's weight in China (Li et al. 2007; Cheng 2004). The reason that a child gains weight is straightforward: energy consumption is greater than energy expenditure. This imbalance between energy consumption and expenditure could be attributable to a myriad of factors.

This dissertation aims to analyze Chinese children's weight changes from two perspectives: parental SES and parental BMI. In the first essay, I build upon the work of Baum II and Ruhm (2009) and explore the relationship between SES and child's weight changes in China. Moreover, I explore how the SES-weight gradient changes with age and other channels (e.g. gender, urban status). It is important to examine the effect of SES over time, since as children grow up, they make more decisions on the food consumption and level of physical exercise that affect their weight. It is interesting to examine whether the impact of SES diminishes or increase over time and how it changes for different subgroups.

In the second essay, I investigate the intergenerational persistence of weight with several major goals. The first one is to explore how children's BMI is related to their parents' BMI, controlling for a myriad of variables, namely SES, demographic variables and environmental variables. I exploit the longitudinal nature of the dataset and use a panel data method to correct for unobserved heterogeneity in analyzing the intergenerational transmission of BMI. Secondly, I use the Blinder-Oaxaca decomposition to quantify the difference in child's BMI between urban and rural areas, since the urban and rural disparities are pronounced in terms of economic prosperity and health care access. To my best knowledge, this study provides the first evidence for the intergenerational transmission of BMI in China, and also the first one to investigate the BMI gap between urban and rural areas. I expect the results to have implications for policy implementation in China with the goal of addressing the ever increasing trend in childhood obesity.

Chapter 2

PARENTAL SES AND CHILD'S WEIGHT

2.1 Introduction

In recent decades, China has started to exhibit some of the children's weight problems commonly seen in more developed countries. Chinese children have experienced larger increase in Body Mass Index (BMI) compared with their peers in the U.S. and U.K. (Ji and Chen 2013). The scenario becomes so worrying that some researchers have already started to document the increase in children's weight in China (Li et al. 2007; Cheng 2004). The reason that a child gains weight is straightforward: energy consumption is greater than energy expenditure. The imbalance between energy consumption and expenditure could be attributable to a myriad of factors.

Existing studies on the determinants of childhood obesity mainly examine the issue from the perspective of general health, arguing that there is an important genetic component of obesity (Stunkard et al. 1990). Recent studies focus primarily on the changes in children's environment that may have led them to consume more calories and expend less energy, such as food available to children in schools (Anderson and Butcher 2006), as well as changes in maternal employment (Anderson, Butcher, and Levine 2003). However, there is a gap in our knowledge when it comes to the effect of socio-economic background on children's weight increase. A classic review of around 70 studies for developed countries shows that the correlation between socio-economic status (SES) and weight is of great importance in characterizing obesity patterns (Drewnowski and Specter 2004; Chang and Lauderdale 2005; Costa-Font and Gil 2008; Baum II and Ruhm 2009). Therefore, it is important to examine how SES affects childhood obesity since parents and children share many environmental factors and parents usually have a lot of influence on their children's diets and physical activities.

Although a vast amount of empirical literature has documented the effect of SES on adult obesity, few have addressed the outcome for children. To my best knowledge, no one has examined the socioeconomic determinants of child's weight changes in China, which leaves a gap in the literature. Over the past 30 years, China has changed to market economy from planned economy with an average GDP growth rate of 10%, it also experienced tremendous social development with massive urbanization, regional disparity and migration. The western lifestyle also brings multiple health concerns such as child's weight increase. For example, it increases the availability and consumption of snacks and sugars, and promotes the proliferation of fast food restaurants that have energy-dense food. On the other hand, it leads to more sedentary activities, such as playing video games and watching television. The western lifestyle is closely related to the economic prosperity of the areas as well as the SES of the families. Therefore, research needs to be conducted to investigate the socio-economic determinants of child's weight increase in China.

In this chapter, I build upon the work of Baum II and Ruhm (2009) and explore the relationship between SES and child's weight changes in China. Moreover, I explore how the SES-weight gradient changes with age and other channels (e.g. gender, urban status). It is important to examine the effect of SES over time, since as children grow up, they make more decisions on the food consumption and level of physical exercise that affect their weight. It is interesting to examine whether the impact of SES diminishes or increase over time and how it changes for different subgroups.

This analysis contributes to the literature by providing a comprehensive analysis of how the impact of socioeconomic status (SES) on weight changes as age increases for Chinese children. The reverse causal path is not feasible since a child's weight is unlikely to significantly influence SES. Rather, SES is mainly caused by the economic circumstances and education of parents. Furthermore, China provides an intriguing case study for several reasons. The pattern of children's weight status in China has distinctive features that are largely different from other countries. Wang (2001) provides a comparison of childhood obesity in different countries. He finds that in China urban children have a higher obesity rate, while in Russia urban children have a lower chance to be obese. Moreover, low-income families are at a higher risk to raise an obese child in both the U.S and Russia. However, in China, children from high-income families are more likely to be obese. Furthermore, in terms of gender, Chinese boys and girls have different risk of obesity even if they are in the same SES level families. Therefore, the relationship between SES and children's weight might be a complicated yet appealing issue due to China's distinct institutional setting, recent structural reforms and great diversity across country.

2.2 Background

2.2.1 Children's Weight Status in China

China is facing rapid growth in children's weight. The measure of children's weight status, which is the key outcome variable, is based on body mass index (BMI). BMI is calculated as weight in kilograms divided by height in meters squared. For children, BMI percentile indicator is a sex-age-specific BMI index based on the 2000 CDC growth charts. To calculate a child's BMI percentile indicator, one could plot the child' BMI number on the CDC BMI-for-age growth charts and it would give a BMI percentile for the child based on his or her age and gender group. Obesity for children is typically defined as having a BMI ranking greater than or equal to 95th percentile. Children are considered overweight if their BMI ranking is greater than 85th percentile, but less than 95th percentile. If children's BMI ranking is at 5th percentile or less, they would be considered as underweight.

Yu et al. (2012) analyze the results from 35 papers (41 studies) on the overweight status and obesity among Chinese children and adolescents during the time period of 1981-2010. Yu et al. find that the overweight status/obesity rate increased from 1.8% and 0.4% respectively in 1981-1985 to 13.1% and 7.5% in 2006-2010. They also find that children in urban areas are more likely to be overweight and obese. Another study conducted by Ji and Chen (2013) notes that in 2010 the overall prevalence for overweight status was 9.9% (12.3% for boys and 7.5% for girls) while for obesity, the prevalence rate was 5.1% (6.7% for boys and 3.4% for girls). Ji and Chen (2013) also argue that regional epidemic rates of overweight status and obesity are in direct proportion to the economic development status of the regions. Specifically, they find that the obesity rate of male students in Beijing went up to 15%, which doubled the 1990 rate and were parallel to that of developed countries by the end of 2000.

The pattern of children's weight status in China has distinctive features that are largely different from developed countries, which may result in some heterogeneous effects of SES in subgroups. First, urban and rural children have different prevalence of obesity (Cheng 2004). The reason is that in urban areas, both parents mostly have full-time work so that they have less time to prepare high-quality, low fat meals. Second, children raised high SES families are more likely to be obese (Wang 2001). Elder children from high-income families usually have more pocket money where they can buy snack foods that are often high in calories. Moreover, these rich elder children dine out more often and the places are usually Western-style fast food restaurants. Third, boys have a higher prevalence of obesity (Song et al. 2013). Due to the traditional Chinese culture, boys are usually favored over girls and they are fed with more food.

Although the question about the association between SES and children's weight status is important, the answer is not very clear-cut as the relationship is complicated by China's distinct institutional setting, recent structural reforms and great diversity across country. Since the pattern of children's weight status in China has distinctive features that are largely different from developed countries, the institutional setting in China probably plays a role in it. Therefore, a review on the institutional factors related to childcare policy in China is necessary and helpful.

2.2.2 Welfare Policies Related to Maternity Leave and Childcare

The health of women and children is always a priority in China with relatively generous maternity leave policies and an abundance of childcare programs. Chinese government has put efforts to ensure that all women and children get access to comprehensive health care services. China is among 173 countries in the world that provide paid maternity leave. China also has formulated many laws to protect women's rights and interests. Another striking feature of China's childcare system is comprehensive kindergarten system for the 2 to 6 years old children. Toddlers and preschoolers are sent to the kindergartens because both parents work full-time and they do not want to send the children to grandmothers. Because of the funding cut for social services, the patterns of childcare provision have changed (Du and Dong 2013). The number of publicly funded kindergarten programs declined by 65% from 1997 to 2006, while the share of private kindergartens increased from 13.5% to 57.8% (Du and Dong 2013). Publicly subsidized high-quality childcare is only provided to parents associated with nonprofit public organizations (NPO) or large state-owned-enterprises (SOE), while other parents have to resort to private or commercialized public kindergartens (Du and Dong 2013).

In addition, one of the biggest distinctive features concerning childcare is the "one-child policy" which greatly shapes the relationship between childhood and parenting in modern China. In 1979, China adopted the one-child policy, allowing newly formed families to have only one child. The implementation of this policy has variations depending on the geographical areas, and the policy is strictly enforced in the cities. Because of this strict family planning policy, a family can only be allowed to have one child. The "illegal" second child may be denied medical and educational services and their parents face the risks of losing their jobs. However, the other side of the one-child policy is that parents are more likely to strengthen the emphasis on caring for the single child. This generation of children are widely known as "little emperors", especially the boys. Children are often the subjects of overindulgence by two parents and four grandparents, and being usually overfed.

2.3 Literature Review

In this section, I review relevant lines of studies centering on the relationship between SES and child's weight in China, such as the established evidence between SES and obesity in developed countries, linkage between economic status and health in childhood, correlation between maternal employment and child's weight, and reasons behind the rise in child's weight in China.

2.3.1 Evidence between SES and Obesity in Developed Countries

Numerous studies have investigated the relationship between SES and obesity for adults in developed countries. Most of the evidence shows that obesity prevalence is highest among lower socioeconomic and socially disadvantaged groups. For instance, Drewnowski and Specter (2004) find that the highest rates of obesity occur among those with the highest poverty rates and the least education. The energy-dense diets are more affordable compared with the diets including lean meats, fish, vegetables and fruit. Therefore, those disadvantaged groups have to buy relatively cheap energy-dense food in order to satisfy caloric requirements, leading to higher chance of being obese. Costa-Font and Gil (2008) provide empirical results suggesting significant relationship between socio-economic inequalities and obesity in

Spain. Moreover, by using the concentration index methodology to decompose the inequalities, they find that education and other demographic variables play important roles on obesity.

In terms of the disparities across demographic groups, some studies show that body mass is negatively correlated with SES for women, but insignificantly correlated with SES for men (see Conley and Glauber, 2007). Variyam (2005) argues that the existence of the disparities in obesity rates across demographic groups can be seen as a justification for policy interventions on social equity grounds.

On the other hand, potential social and income inequality might be due to the discrimination against obese people. Gortmaker et al. (1993) use panel data from NLSY and find that obese women between the ages of 16 and 24 experienced worse outcomes 7 years later and the differences in marital status, household income, poverty rates, and years of schooling are significant. In contrast for men, the only significant effect is a reduction in the probability of marriage. Averett and Korenman (1999) examine the mechanisms that could account for the racial differences in the effects of obesity on women's SES. They find obesity significantly reduces white women's likelihood of marriage and their spouse's income. In contrast, this mechanism does not work for black women.

Baum II and Ruhm (2009) examine how the relationship between weight and SES changes from early childhood to adulthood. They use data from the National Longitudinal Survey of Youth (NLSY) and find that weight is positively correlated with age but inversely correlated with SES. Moreover, the SES gap propagates through race/ethnicity. They also find that half of the correlation between SES and weight still exists after adding controlled variables, signifying the need to further examine the channels for the SES disparities.

2.3.2 Evidence between Economic Status and Child's Health

Relevant studies include the examination of the relationship between economic status and child's health. Case, Lubotsky, and Paxson (2002) use data from four different sources and present evidence for the positive relationship between SES and child's health, which is known as gradient. The positive relationship between SES and child's health becomes more pronounced as child ages (e.g. SES-health gradient rotates). This implies that the low income could have a negative impact on a child's health, and this negative effect is likely to accumulate over time. Currie and Stabile (2003) argue that Case, Lubotsky, and Paxson (2002)'s study could not distinguish between two possible explanations: 1) the harmful effects accumulate because low-SES children are less likely to recover or 2) low-SES children have more negative health shock over time. The identification of the explanations would shed light on the policy implementation scheme.

Therefore Currie and Stabile (2003) use Canadian data from National Longitudinal Survey of Children and Youth (NLSCY) and find similar gradient as the estimates using U.S. children. They find the second explanation is important in the SES-health relationship.

Following Currie and Stabile (2003), Condliffe and Link (2008) use panel data on U.S. children and confirm the positive relationship between SES and health. They also find that the gradient rotates as child grows up. Furthermore, they show that both explanations for the steepening gradient are true. Children from low SES families are subject to more new health shocks compared to high SES children. And children from low SES families have a higher chance to have harmful effects of the chronic conditions five years later.

2.3.3 Evidence between Maternal Employment and Child's Weight

Recently, developed countries have seen an increase in maternal employment rate that is accompanied by the increase in child's weight. To explain the correlation, a plethora of economic literature hypothesizes that maternal employment leads to less time spent at home and results in less time supervising and caring for children. Previous studies for developed countries have drawn a strong linkage between maternal employment and child's weight, although they use different methods and control variables (Chia 2008; von Hinke Kessler Scholder, Stephanie 2008). For example, one pioneering study from the U.S. indicates that more hours a mother worked per week, the more likely the child is overweight (Anderson, Butcher, and Levine, 2003). Anderson et al. use the National Longitudinal Survey of Youth (NLSY) and firstly provide evidence for the correlation between maternal employment and child's weight. Then they use several techniques such as probit model, sibling difference and instrumental variables models to further determine whether the relationship is causal. They conclude that mothers who work longer hours are more likely to have an overweight child. They also find that the relationship is more pronounced among high SES families.

Many studies have investigated the potential pathway through the type of childcare. Overall, the quality of childcare matters in affecting children's weight. For example, Pearce et al. (2010) find that informal care (primarily by grandparents) is related with high likelihood of having overweight children.

However, maternal employment may not necessarily have negative impact on child's weight issue. The increase in income allows the flexibility in purchasing goods that substitute for the mother's time (e.g. food preparation, professional supervision in physical activities). Moreover, the quality of childcare also matters. Greve (2011) uses Danish data and finds no significant relationship between maternal employment and the likelihood of child's being overweight. He tests the following four hypotheses: the effect of maternal employment on child's weight has different impacts across the weight distribution; the relatively higher quality of childcare in Denmark; low quality child care from Danish mothers; significant contribution from Danish fathers in child care. The empirical evidence provides support for the second and fourth hypotheses.

2.3.4 Explaining the Rise in Child's Weight in China

To explain the rise in child's weight in China, a substantial literature focuses on whether the changes in diet structure (e.g. more consumption of specific types of food such as fast food) and changes in particular activities affect the weight increase.

Many researchers argue that the rise in overweight/obesity rate in China results from the nutrition transition associated with the recent economic development and expansion of agricultural production (Popkin et al. 1993; Du et al. 2002). Moreover, recent economic growth and agricultural expansion have shifted the dietary structure toward consumption of more energy-intensive foods. Meanwhile, the dietary changes have been accompanied by an increase in sedentary lifestyles that discourage physical activities. However, these explanations cannot answer why there is only a surge in obesity during childhood, but not in adulthood. Therefore, it is important to consider other factors that could cause a child to be overweight. Li et al. (2007) analyze China

Health and Nutrition Survey data on 6,826 children with ages from 7 to 17 years old and find that parental weight is important in predicting child's weight. Parents have a genetic influence and they also play a dominant role in affecting children's eating and activity behaviors. Based on their empirical results, Ji and Chen (2013) suggest the following strategies that help prevent childhood obesity: reasonable dietary intake, more physical activity, changes in sedentary lifestyles and corresponding behavioral modifications.

Obesity is also a health problem. Some researchers attribute at least part of child health determinants to maternal care. Liu (2008) examines China Health and Nutrition Survey data and finds that maternal employment still has a negative impact on child health. This negative impact is greater when mothers participate in non-agricultural work. In the analysis of migratory employment, Chen (2009) also finds a negative impact for children having a shortage of maternal care in China. More recently, Yao (2011) estimates a joint system of dynamic empirical equations containing mother's work time, childcare time, health shocks to the child, mother's income and health production. He also confirms that maternal decisions are crucial in determining the health status of children. Moreover, the different work types in rural areas affect children's health in different ways.

2.4 Theoretical Framework

The theoretical framework is largely based on Baum II and Ruhm (2009)'s work on the production of body weight. What has interested many researchers is the determination of body weight; the production function of body weight could be specified as follows:

(2.1) $\Delta W_{it} = W_{it} - W_{it-1} = E_{it} - (M_{it} + P_{it})$

where W_{it} is the body weight of person i at time t, E_{it} is the calorie intake of person i at time t, M_{it} is the metabolism of person i at time t for essential body functions measured by calories, and P_{it} is the calorie expenditure during physical activity for person i at time t. Body weight increases between time t and t-1 if calorie intake is larger than energy expenditure. It is clear that a person experiences weight increase if energy intake exceeds energy expenditure through metabolism and physical activities. Metabolism usually depends on personal genetics (α_i) and body weight (W_{it}), as shown in Equation (2.2). In (2.2), $\beta > 0$ since weight increase will raise the amount of energy needed to support body functions. I assume α does not vary by time for simplicity.

(2.2) $M_{it} = \alpha_i + \beta_i W_{it}$

Substituting equation (2.2) into (2.1) yields:

(2.3) $\Delta W_{it} = W_{it} - W_{it-1} = E_{it} - \alpha_i - \beta_i W_{it} - P_{it}$

Therefore, individuals will experience weight gains if they consume more calories ($E_{it} \uparrow$), are less active ($P_{it} \downarrow$), or they have lower metabolism, expressed by lower α_i or β_i or W_{it} which vary by individuals. SES can be related to the patterns of energy intake and expenditure, therefore, affect body weight.

2.5 Data Description

2.5.1 Data Sample

I use data from China Health and Nutrition Survey (CHNS)[1], conducted by the Carolina Population Center and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. This survey adopts a multistage, random cluster process and gathers sample from individuals, households and their communities. The survey began with eight provinces: Jiangsu, Liaoning, Henan, Shandong, Hubei, Hunan, Guangxi and Guizhou, and later added a ninth Heilongjiang in 1997. These provinces could represent China as a whole. The urbanization percentages for the above provinces are 59%, 53%, 47%, 34%, 44%, 40%, 36%, 28% and 54% respectively (Donald and Benewick 2008). Furthermore, the CHNS sample added three province-level municipalities--Beijing, Shanghai and

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1 "This research uses data from China Health and Nutrition Survey (CHNS). I thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention, Carolina Population Center, the University of North Carolina at Chapel Hill, the NIH (R01-HD30880, DK056350, and R01-HD38700) and the Fogarty International Center, NIH for financial support for the CHNS data collection and analysis files from 1989 to 2006 and both parties plus the China-Japan Friendship Hospital, Ministry of Health for support for CHNS 2009 and future surveys."

Chongqing--in the most recent wave in 2011. These three cities have better economic performance and are comparatively more prosperous. Counties in each province are firstly stratified by income, and then four counties are randomly selected through a weighted sampling scheme. In addition, two cities in each province are included in the sample as well. If feasible, the capital in the province and a lower income city are selected. In each community, twenty households are randomly selected and all household members[2] are interviewed in the process (Popkin et al. 2010). Overall, a total number of 26,000 individuals in around 4,400 households are drawn in the sample. The CHNS sample is randomly selected to make sure that it captures a wide range of economic and demographic circumstances in China.

CHNS is designed to analyze the effects of health and nutrition polices in the context of social and economic transformation in China. The individuals in the sample come from towns that vary significantly in demographics, economic development and health resources. CHNS has nine rounds in total: 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011. The data are longitudinal where each person has his/her own ID, which is consistent across all survey years. For adults, CHNS provides information on occupation, education, income, time use, marriages, land ownership, assets, housing conditions and other demographic traits. For children, CHNS contains rich information on health outcomes, weight, height, food and nutrition intake, nutrition knowledge, sedentary activities and physical activities.

In the analysis, I restrict the analysis sample to children with ages between 2 and 18, and match the children and their parents through the relationship identifier in

2 There is an exception in CHNS 1989, where only children aged less than 6 years and adults with ages between 20 and 45 are interviewed. Therefore wave 1989 is excluded from the analysis.

the datasets. After careful data collection and cleaning, I have 19,160 child-parents matching observations with 8,578 different children from wave 1991 to 2011. For each observation, I have the survey year, and child's information attached with his/her parents' information.

The measure of children's weight status, which is the key outcome variable, is based on body mass index (BMI). For children, BMI percentile indicator is a sex-age-specific BMI index based on the 2000 CDC growth charts[3]. To calculate a child's BMI percentile indicator, one could plot the child' BMI number on the CDC BMI-for-age growth charts and it would give a BMI percentile for the child based on his or her age and gender group. Obesity for children is typically defined as having a BMI ranking greater than or equal to 95^{th} percentile. Children are considered overweight if their BMI ranking is greater than 85^{th} percentile, but less than 95^{th} percentile. If children's BMI ranking is at 5^{th} percentile or less, they would be considered as underweight[4]. Alternative measures to BMI, for example, skinfold thickness measurement is also available in CHNS. However, most researchers have chosen to use BMI since it is highly correlated with other measurements of obesity. Moreover, for children, the skinfold thickness measurement adds little additional value for measuring obesity (Mei et al. 2007).

The key variable SES in this dissertation has two proxies: the highest grade completed by child's parents and household income. For the education level, I

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3 The age-gender specific BMI percentile used for determining obesity and overweight status was calculated using the following five national surveys:
NHES II (1963–65) and III (1966–70), and NHANES I (1971–74),II (1976–80), and III (1988–94)
4 For the rest of the dissertation, any BMI measure (e.g. BMI ranking, BMI percentile, BMI) for children refer to BMI percentile indicator.

followed Baum II and Ruhm and divided the sample into low, medium and high education/SES groups, which are determined by the years of completing schools. The choice of the cut-offs is determined based on the following two rationales: 1) conventional school grade level cut-off (e.g. no education/primary school, middle/high school, and college); 2) average and distribution of education level of the sample[5]. Therefore, "low" SES is defined as completing <= 6 years of formal education, "medium" SES is defined as completing 7-12 years of formal education and the rest are classified as "high" SES. In my analysis sample, 28.41%, 66.39% and 5.2% of the children fall into "low", "medium" and "high" SES groups. For household income, which is the other proxy for SES, I use a continuous variable. The mean household income values for "low", "medium" and "high" education groups are 8,872, 16,418 and 50,554 yuan respectively, implying that education level and household income level are positively correlated. This suggests that the education-based measures for SES are likely to be useful.

Additional variables included in the analysis are parents' smoking and drinking behaviors, child's gender, urban status, province, parents' ages and parents' BMI levels. The information is all collected in the same year as the weight was measured. The question for the smoking behavior is whether the person ever smoked cigarettes. The question for the drinking behavior is whether the person drank beer/alcohol last year. Parents' BMI is calculated as weight in kilograms divided by height in meters squared. These additional variables are controlled for in the models to capture the effects of environmental, lifestyles and genetic factors on child's weight. However,

5 Please refer to Appendix A.3 for detailed discussions on the choice of SES cut-offs.

they are not interpreted as having a causal impact on child's weight in this analysis, but as proxies for the inputs that may relate to child's weight.

Table 2.1 presents descriptive statistics for BMI, overweight status, obesity and many other important variables. I show the results for the full sample, and for gender and SES subsamples. SES here is a trichotomous variable measured by parents' highest education level. The obesity rate is higher for boys (4.8%) than girls (3.3%), which is not a surprise since Chinese boys are usually more spoiled by parents and have more pocket money to buy western-style food with high calories. High SES families, as measured by education level, are more urbanized, have higher household income, drink more, but smoke less. However, contrary to the evidence found in developed countries (see Baum II and Ruhm), these high SES households have more obese and overweight children (8.6% and 18.8%, respectively). The same pattern can be found for their fathers. Fathers in the high SES household have average BMI level of 24.3, much higher than the value (21.7) for low SES household. It is not surprising, since these high SES people have gradually acquired a taste for processed grains and flour and their children get more access to the food with higher fat and sugar content. Mothers smoke less than fathers, which might be attributed to social disapproval of women smoking and to women's relatively low socio-economic status.

Table 2.1: Descriptive Statistics by Gender and SES/Education, CHNS, Children, Age 2-18, 1991-2011

	Full	Gender		SES/Education		
	Sample	Males	Females	Low	Medium	High
Obese%	4.1%	4.8%	3.3%	2.6%	4.4%	8.6%
Overweight[6] %	10.1%	11.1%	9.0%	6.6%	11.0%	18.8%

6 Overweight here and in the following also includes the obesity category (e.g. BMI ranking>=85).

Age	10.3	10.3	10.3	11.8	9.7	10.0
Male%	53.4%	100%	0	53.7%	53.7%	49.1%
Father's BMI	22.4	22.4	22.4	21.7	22.5	24.3
Mother's BMI	22.3	22.3	22.4	22.3	22.4	22.1
Father's Drink%	70.0%	69.3%	70.8%	68.8%	70.2%	72.6%
Mother's Drink%	12.1%	12.3%	11.9%	12.2%	11.2%	22.4%
Father's Smoke%	69.4%	67.9%	71.2%	74.9%	68.6%	54.7%
Mother's Smoke%	2.2%	2.1%	2.3%	3.4%	1.8%	0.7%
Urban%	27.4%	26.4%	28.5%	18.1%	28.1%	67.9%
Household Income	16,048.6	15,977.0	16,130.8	8,871.7	16,417.8	50,554.1
Father's Income	7,409.8	7,381.5	7,442.5	3,711.9	7,504.1	23,979.0
Mother's Income	5,504.7	5,564.2	5,436.2	3,149.7	5,425.9	19,158.4
Father's Age	38.5	38.4	38.6	41.9	37.2	38.8
Mother's Age	36.9	37.0	36.9	39.8	35.7	36.8
N	19160	10236	8924	5443	12721	996

Note: The unit of income is Renminbi. The exchange rate has the range of 0.12-0.16 US dollar per Renminbi from 1990-2015.

2.5.2 Changes in Child's Body Weight Patterns

This section shows the child's weight change patterns through several dimensions: time, province, age, and SES. Taken together, they depict a comprehensive picture of Chinese children's body weight trends.

I first examine a child's weight change over time. As shown in Figure 2.1, the percent of children who are obese has increased sharply from 2.8% in 1991 to 10.4% in 2011. During 1990s, obesity rate barely has any changes. From 2000 to 2009, there is an increasing trend in obesity rate. However, the rate increases dramatically from 2009 to 2011. Part of the reason contributing to the suddenly high obesity rate in 2011 is that three province-level municipalities (Beijing, Chongqing and Shanghai) were added in the most recent wave (2011). These three cities have better economic performance and are comparatively more prosperous. Children in these cities have comparatively higher obesity rate compared with the rest of China. Considering this factor, the result in 2011 is comparable to Yu et al.'s evidence which shows that the obesity rate was 7.5% in 2006-2010.

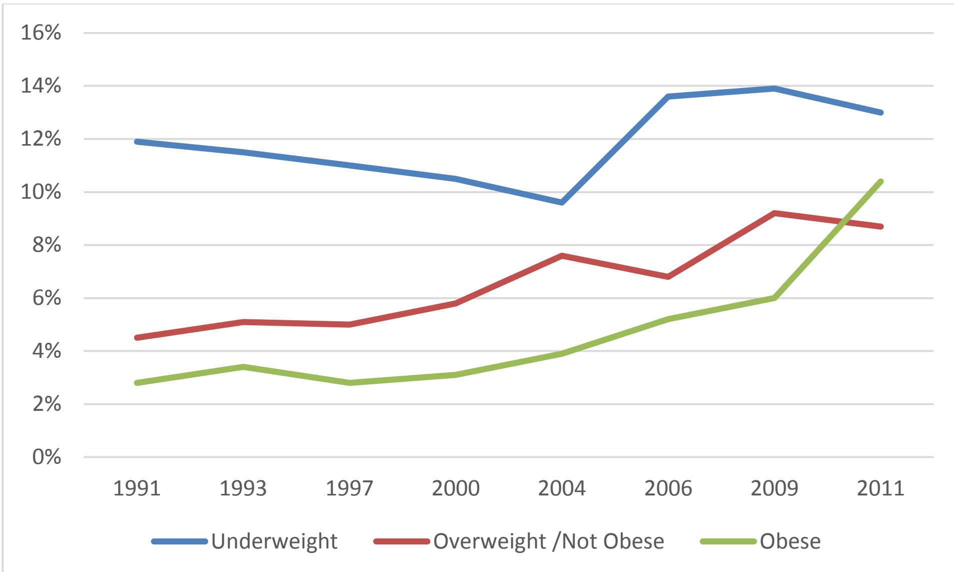

Figure 2.1: Child's Weight Status by Wave, CHNS, 1991-2011

Note: The sample includes 19,160 observations from the China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011). The category "overweight/not obese" includes children with BMI ranking between 85^{th} and 95^{th} percentiles. "Underweight" includes children with BMI ranking less than 5^{th} percentile. "Obese" includes children with BMI ranking equal to or greater than 95^{th} percentile.

As noted above, the overweight and obesity rate has been largely influenced by including large cities such as Beijing, Shanghai and Chongqing. Figure 2.2 shows that the child's weight varies by geographical regions in China due to great diversity across the country. For cities like Beijing and Shanghai, the obesity rate is around 15% while for a province like Guangxi, the obesity rate is only 1%. This graph shows that the child's overweight and obesity prevalence is positively correlated with the economic prosperity of the area. However, note that this graph can only be used for illustration purposes since the sample calculating the weight information for Beijing, Shanghai and Chongqing has only 2011 wave while the sample calculating the weight information for the other provinces include the wave from 1991 to 2011.

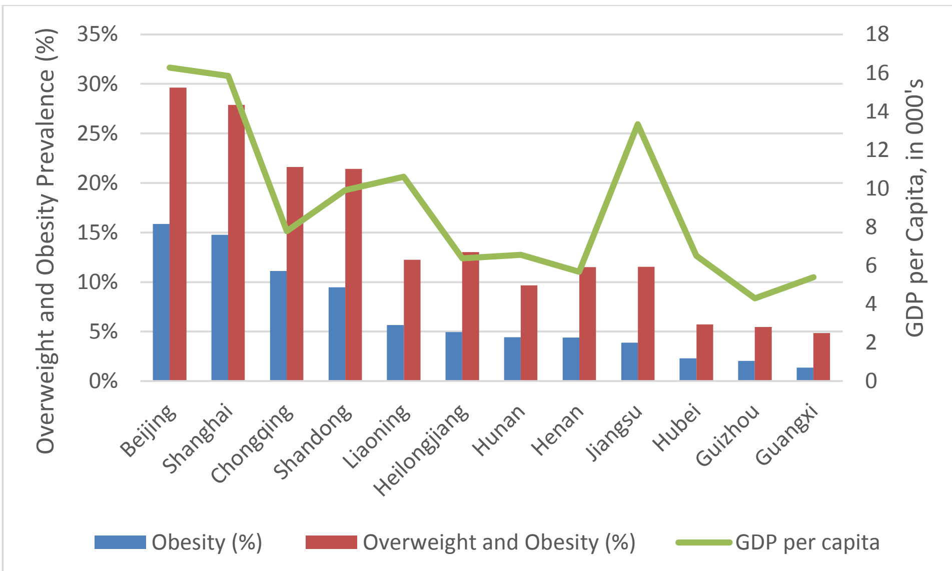

Figure 2.2: Childhood Overweight and Obesity Prevalence and GDP per Capita by Province, CHNS, 1991-2011

Note: GDP per capita is in US$ based on 2014 statistics with mid-year population. Data source is from IMF WEO April 2015. Data measuring overweight and obesity prevalence come from CHNS 1991-2011.

Figure 2.3 shows overweight and obesity prevalence by child's age. As we can see, overweight and obesity prevalence grows rapidly with age before 4 years old, but declines gradually till 18 years old. The peak of obesity rate in 4 years old is explained in Appendix A.1, where the BMI ranking for obesity cut-off is lowest around age 4. The decline effect after 4 years old may be underestimated due to secular trends. The age profile also shows some weak evidence of concavity, which might suggest that age-squared term could be used in predicting obesity. The result of declining overweight and obesity prevalence with age differs from Baum II and Ruhm's result where in their sample of American adults, BMI and obesity prevalence grow rapidly with age: average BMI rises from 21.8 to 26.9 while obesity rate increases from 1% to 23.2% between 18 and 40 years old.

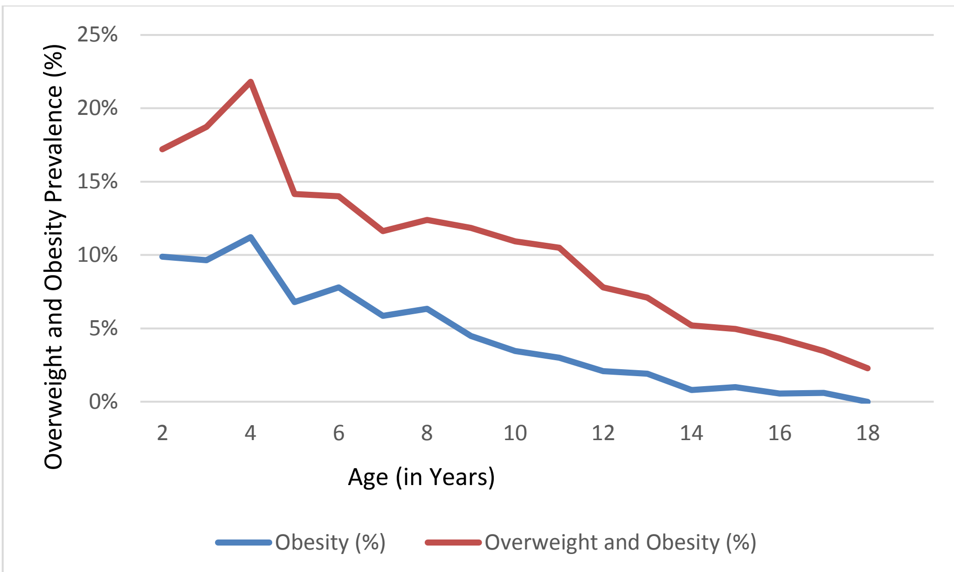

Figure 2.3: Overweight and Obesity Prevalence by Child's Age, CHNS, 1991-2011

Figure 2.4 displays the age-specific obesity prevalence by SES characterized by education level. Several take-away messages are worth pointing out. Firstly, we observe an age-related decrease in obesity prevalence, especially for low and medium SES group. However, for high SES group, obesity prevalence grows rapidly with age before 4 years old, but declines gradually till 18 years old. Secondly, obesity prevalence is more of a problem for high SES group. Thirdly, a linear approximation of the relationship between age and obesity rate is reasonable for low and medium SES groups while I allow for nonlinear age effects for the high SES group. Fourthly, the gradient of SES and obesity prevalence rotates with age. For instance, 20.8%, 10.1% and 12.8% of children are obese at age 4. However, the rates become close to 0 after 16 years old. In other words, SES differences are more pronounced for obesity at early age, but the differences decrease rapidly later.

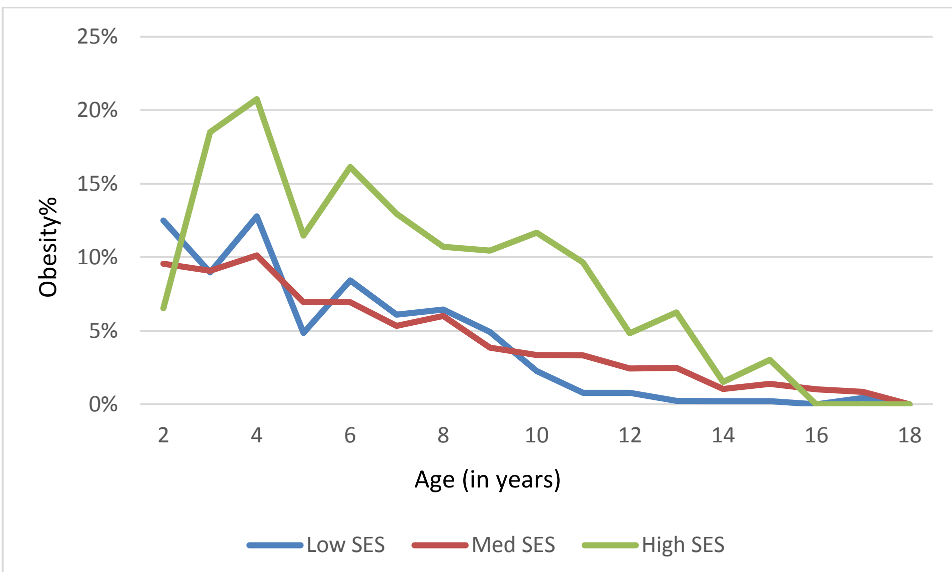

Figure 2.4: Age-specific Obesity Prevalence by SES, CHNS, 1991-2011

Table 2.2 shows the child's weight distribution by urban/rural status, SES group and gender. Although urban children and boys are more likely to be overweight or obese, the sharpest contrast occurs by SES group, where the low SES group has

4.0% and 2.6% of overweight and obese children while high SES group has 10.1% and 8.6%.

Table 2.2: Child's Weight Status by Different Attributes: Urban/Rural, SES and Gender, CHNS, 1991-2011

	Underweight	Overweight/Not Obese	Obese
Urban	10.0%	7.8%	4.8%
Rural	12.3%	5.3%	3.9%
Low SES	12.1%	4.0%	2.6%
Med SES	11.8%	6.5%	4.4%
High SES	7.4%	10.1%	8.6%
Male	12.4%	6.3%	4.8%
Female	10.8%	5.6%	3.3%

Note: the sample includes 19160 observations from the China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011). The category "overweight/not obese" includes only the children with BMI ranking between 85^{th} percentile and 95^{th} percentile.

2.6 Methodology

2.6.1 Linear Model and Logistic Regression

In this section, I investigate the impact of socioeconomic status (SES) on child's weight as age increases and how the SES-weight gradient differs with various channels. To account for China's special institutional setting, I examine whether the impact of SES differs by urban/rural residency. The following equations describe the empirical model specifications.

(2.4) $Y_{it} = \alpha + \gamma_1 SES_{it} + \gamma_2 AGE_{it} + X\beta + \mu_{it}$

$$(2.5)\ Y_{it} = \alpha + \gamma_1 SES_{it} + \gamma_2 AGE_{it} + \gamma_3 AGE_{it} * SES_{it} + X\beta + \mu_{it}$$

where Y_{it} represents the weight outcome (BMI ranking or overweight/obese status[7]) for person i at time t, SES_{it} is the socioeconomic status for person i at time t. AGE_{it} is the respondent's age at time t, X is a vector of control variables such as child's gender, urban/rural status, mother's BMI and father's BMI, and μ_{it} is the error term. An age quadratic term is also included to capture the nonlinear effect of age. Following Baum and Ruhm, I proxy SES by highest education level by mother or father and household income. Equation (2.4) is a basic estimation equation to investigate the relationship among weight, age and SES. In equation (2.5), by adding the age and SES interaction term, I relax the assumption that the impact of SES is age-invariant and allow the effect of SES to differ with age. Adding the interaction terms to the regression model could add to our understanding of the relationship between SES and outcome variable, and allow more hypotheses to be tested. I do not initially control for parents' health behaviors such as smoking and drinking, because they may act as mechanisms through which SES operates and influences child's weight. I add these variables later to help understand whether they act as channels from SES to child's weight. All equations contain survey data wave dummies as well as place dummies

The model can be specified as a simple linear regression or linear probability model depending on whether the outcome variable is a continuous variable (BMI ranking) or dichotomous (overweight status and obesity). Furthermore, I can also

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7 In the empirical analysis section, the obese / overweight status as the outcome variables are defined as BMI ranking equal to or greater than 95th / 85th respectively.

estimate a logit model to measure the impact of SES on the dichotomous measures (overweight status/obesity). The estimated equation is as follows:

(2.6) $\text{Logit}(W_i) = \alpha + \gamma_1 SES_i + \gamma_2 AGE_i + X\beta + \mu_i$

where W is the weight status for a child. Specifically, W=1 if the child has a BMI ranking beyond 85^{th} percentile or 95^{th} percentile (i.e. being overweight or obese). Otherwise, W=0. The coefficient γ_1 estimates the effect of SES on the outcome of interest.

2.6.2 Quantile Regression

The traditional least squares model estimates the effect of independent variables on the conditional mean of the dependent variable. However, the traditional least squares model is inappropriate in the context of obesity analysis, because BMI is not a monotonic indicator of health conditions (either too high or too low is not ideal). And the effects of the independent variables in different percentiles of BMI distribution convey very different implications. For example, suppose a variable only has a positive effect on lower percentile of BMI distribution, it cannot be considered a contributor to obesity. Instead, it helps underweight people return to normal weight.

Quantile regression, proposed by Koenker and Bassett (1982), is a useful tool to estimate the conditional quantiles of a response given a vector of regressors. It is a semi-parametric method, because it makes no assumptions on the conditional distribution of the estimated parameters, although the conditional quantile has a linear form. Quantile regression measures the effects of regressors not only in the center of the distribution, but also in the upper and lower tails. Indeed, we may expect that in the lower quantiles of BMI distribution and in the upper quantiles of BMI distribution, the effects of SES are different. Therefore, I will estimate quantile regression models at selected points, e.g. 25% and 75%, in addition to the median of the BMI. The robustness of the results is ensured by using different estimation strategies of quantile regression models (asymptotic estimation with iid assumption on the error structure).

The BMI quantile regression pertaining to the θth quantile can be expressed as:

(7) $BMI_i = \beta_\theta X_i + \varepsilon_{\theta i}$

(8) $Q_\theta(BMI_i|X_i) = \beta_\theta X_i$

where β_θ is a vector of coefficients, X_i is a vector of explanatory variables and $\varepsilon_{\theta i}$ is the error term. The kth element of β_θ shows the marginal effect of the kth regressor.

(9) $\beta_{\theta k} = \frac{\partial Q_\theta(BMI_i|X_i)}{\partial X_{ik}}$

β_θ is the marginal change in the θth conditional quantile as a result of a change in X_i. Therefore β_θ probably varies over different quantiles.

Another reason to use quantile regression is to mitigate the possible error of using the BMI cut-off points developed by CDC in 2000 to define childhood obesity/overweight status. Since Asian populations have different body-fat percentiles for the same BMI compared to the U.S. white population, the definition for childhood obesity/overweight status might be different from 95 percentile and 85 percentile of sex-age-specific BMI index. By using quantile regression, I could assess the effect of SES at all possible high percentiles (e.g. 90%, 99%).

2.7 Econometric Estimates of SES on Child's Weight

Using the sample of the CHNS described above and the models developed in the previous section, I discuss the results from the econometric estimates for the full sample, as well as the stratified sample by gender, urban/rural status and wave.

2.7.1 OLS Estimates of SES on Child's Weight Status

2.7.1.1 SES as Proxied by Parents' Education Level

Table 2.3 summarizes the basic OLS results examining the effects of age and SES on child's weight. The other covariates include the relevant contemporaneous demographic variables such as child's gender, urban/rural status, parents' BMI, location dummies and wave dummies. The dependent variable is BMI ranking in Columns (1) and (2), overweight or obese status in columns (3) and (4), and whether obese in Columns (5) and (6). BMI ranking is a continuous variable ranging from 0 to 100. Overweight/obesity is a binary variable with the value of 1 if the child's BMI ranking is above the 85^{th} percentile (overweight) or 95^{th} percentile (obesity) for his/her age and gender. Otherwise, it has the value of 0. Columns (2), (4), and (6) include an age-SES interaction, while the rest do not. SES here is defined as the highest education level attained by parents. The reference levels for SES, survey wave and location are no education/primary school, 1991, and Beijing respectively. Notably, the sample size drops to 12,311 compared with the sample size of 19,160 in the data description section. The reason is that some of the observations are dropped in the regression due to the lack of either father's or mother's information. In Appendix A.2, I compare the sample of 12,311 and the excluded sample of 6,849 in terms of the group mean of overweight and obesity level. Not much difference exists between these two samples in terms of child's weight, therefore I rule out the attrition effect.

Table 2.3: OLS Estimates of Effect of SES on Children's BMI, Overweight Status and Obesity, CHNS, 1991-2011

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-1.881**	-1.705**	-0.0127**	-0.0142**	-0.0119**	-0.0120**
	(-7.45)	(-5.83)	(-4.78)	(-4.61)	(-6.60)	(-5.77)
Child's Age-Square	0.0468**	0.0438**	5.04E-05	7.64E-05	0.000226**	0.000230**
	(3.85)	(3.53)	(0.39)	(0.58)	(2.62)	(2.62)
SES: Parent Education Level						
Middle/High School	-0.426	1.318	-0.00612	-0.0224	-0.00965**	-0.0136
	(-0.70)	(0.83)	(-0.96)	(-1.34)	(-2.24)	(-1.20)
College and Above	4.557**	6.456**	0.0388**	0.0502*	0.0151*	0.0565**
	(3.70)	(2.25)	(2.99)	(1.66)	(1.73)	(2.77)
Child's Age * SES						
*Age*Middle/High School*		-0.155		0.00149		0.000419
		(-1.18)		(1.07)		(0.45)
*Age*College and Above*		-0.169		-0.00121		-0.00401**
		(-0.69)		(-0.47)		(-2.30)
Male	0.70	0.71	0.0227**	0.0227**	0.0180**	0.0181**
	(1.43)	(1.45)	(4.41)	(4.40)	(5.19)	(5.20)
Urban Status	2.044**	2.041**	0.0217**	0.0218**	0.00294	0.00304
	(3.58)	(3.58)	(3.61)	(3.62)	(0.72)	(0.75)
Father's BMI	1.226**	1.227**	0.00700**	0.00700**	0.00326**	0.00328**
	(15.26)	(15.27)	(8.26)	(8.26)	(5.72)	(5.74)

Mother's BMI	1.555**	1.558**	0.00876**	0.00874**	0.00286**	0.00288**
	(18.08)	(18.10)	(9.66)	(9.64)	(4.68)	(4.71)
Constant	1.057	-0.699	-0.113**	-0.102**	-0.0134	-0.0166
	(0.28)	(-0.17)	(-2.82)	(-2.36)	(-0.49)	(-0.57)
N	12311	12311	12311	12311	12311	12311
R-sqrd	0.138	0.138	0.088	0.088	0.063	0.063

Note:

1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

Without controlling for the interaction effect, the impact of age on a child's BMI ranking could be calculated as: -1.881+2*0.0468*age (see column 1), which suggests that BMI ranking declines rapidly at first, but then less rapidly as the child ages. For example, at age 2, child's BMI ranking decreases by 1.69 percentiles as child ages by one year, while at age 6, child's BMI ranking only decreases by 1.32. For SES, I find a very large effect of the parent having a college degree or higher on all three weight measures. For high SES group compared with median SES group, BMI ranking increases by 4.56 (see column 1), while the prevalence of overweight status and obesity increase by 3.88 and 1.51 percentage points respectively (see columns 3 and 5). In contrast, the effect of parent having a middle/high school education compared with parent with lower education is small and barely significant. One of the reasons might be that children born in the high SES families are more likely to be incorporated into globalization, get access to the western lifestyle and eat fast food. In contrast, low and median SES families are less likely to be exposed to such food environments.

Controlling for the age and SES interaction effect increases the impact of high SES (see columns (2), (4), and (6)). As shown in column (6), SES disparities narrow with age (e.g. age*SES interaction is negative). The result is consistent with 2.2.4, which displays the age-specific obesity prevalence by SES characterized by education level. SES differences are more pronounced for obesity at an early age, but the differences decrease rapidly later. The prevalence of overweight and obesity likely attenuates with age since a child begins to care more about personal image as he or she grows up, especially during adolescence.

The parents' BMI information included in these models provide evidence that parental weight status is a very important risk factor. The parents' BMI levels have a significantly positive impact on child's weight, with reasons varying from genetic factors to similar diet choices.

In short, the results show that: 1) Childhood overweight and obesity prevalence drops as a child ages; 2) SES, as proxied by parents' education level, is positively related to a child's weight increase; 3) The SES disparities decrease as a child ages. It is not surprising to see the prevalence of overweight and obesity attenuates per age since a child begins to care more about their personal images as he or she grows up, especially when entering into adolescence. Moreover, recent economic growth has shifted the dietary structure towards consumption of more energy-intensive foods. High SES families are more affected by this change, thus children in high SES families are more likely to gain unnecessary weight. Fortunately, such impacts from SES diminish as child ages.

2.7.1.2 SES as Proxied by Household Income

Table 2.4 shows a parallel set of models as Table 2.3, except that SES is specified as a continuous variable measured by household income (Renminbi, in thousand). The age effects are identical: the impact of age on a child's BMI ranking is -1.859+2*0.0462*age (see column 1), which suggests that BMI ranking declines rapidly at first, but then less rapidly as the child ages. Similarly, the relationship between child's weight and SES is positive. BMI ranking increases by 0.0248 given a 1000 yuan increase in household income. The SES disparities widen with age as measured by BMI. But the SES disparities narrow with age as measured by obesity. Therefore, the results show the complexity of the effect of SES, especially on the tails of the BMI distribution. In light of this, I am cautious of using the continuous SES measurement (household income), although it is easy to interpret. My concern is that the results might be sensitive to outliers and the effect of household income might be nonlinear as well.

Table 2.4: OLS Estimates of Effects of SES (Household Income) on Children's BMI, Overweight Status and Obesity, CHNS, 1991-2011

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-1.859**	-1.978**	-0.0125**	-0.0128**	-0.0117**	-0.0109**
	(-7.35)	(-7.72)	(-4.67)	(-4.72)	(-6.53)	(-5.98)
Child's Age-Square	0.0462**	0.0477**	4.42E-05	4.79E-05	0.000230**	0.000220**
	(3.80)	(3.92)	(0.34)	(0.37)	(2.66)	(2.54)
HH Income	0.0248**	(0.02)	0.000337**	0.00	0.00	0.000416**
	(2.01)	(-1.16)	(2.59)	(0.93)	(0.66)	(2.73)
Child's Age * HH Income		0.00544**		0.00		-0.0000392**
		(2.83)		(0.69)		(-2.87)
Male	0.66	0.65	0.0225**	0.0224**	0.0179**	0.0179**
	(1.35)	(1.34)	(4.36)	(4.36)	(5.15)	(5.17)
Urban Status	2.400**	2.330**	0.0240**	0.0238**	0.00	0.00
	(4.31)	(4.18)	(4.08)	(4.05)	(1.03)	(1.16)
Father's BMI	1.242**	1.241**	0.00709**	0.00709**	0.00331**	0.00331**
	(15.50)	(15.50)	(8.40)	(8.40)	(5.81)	(5.82)
Mother's BMI	1.525**	1.528**	0.00852**	0.00853**	0.00272**	0.00270**
	(17.80)	(17.83)	(9.44)	(9.44)	(4.47)	(4.44)
Constant	2.654	3.704	-0.104**	-0.101**	-0.00846	-0.016

	-0.7	-0.98	(-2.61)	(-2.53)	(-0.32)	(-0.59)
N	12311	12311	12311	12311	12311	12311
R-sqrd	0.137	0.138	0.088	0.088	0.062	0.062

Note:
1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

2.7.1.3 Smoking and Drinking Behaviors

The analysis results from the previous sections established that: 1) child's weight gradually decreases during the transition from 2 years old to 18 years old, 2) children growing up in high SES families have higher weights, and 3) SES disparities narrow with age. Now I examine the potential channels that SES may operate through. Specifically, I test whether SES may have an impact on child's weight through parents' smoking and drinking behaviors. These estimates are shown in Table 2.5. I use the model specification with the age-SES interaction. The results in Table 2.5 suggest that the effect of SES on BMI ranking increases after controlling for parents' smoking and drinking behaviors. When these behaviors are included, the effect of high SES on BMI ranking increases from 6.456 (Table 2.3) to 6.966. For overweight status or obesity, the effects are very similar. Furthermore, mother's smoking has a negative effect on child's obesity. If the mother smokes, the child is 1.19 percentage point less likely to be obese, although this effect is statistically insignificant. Overall, the difference is quite small after controlling for parents' health behaviors (drinking, smoking). Therefore, the impact of SES may not operate through parents' health behaviors (drinking, smoking).

Table 2.5: OLS Estimates of Effects of SES (Education Level) in Children's BMI, Overweight Status and Obesity Controlling for Smoking and Drinking, CHNS, 1991-2011

	(1)	(2)	(3)
	BMI	Overweight	Obesity
Child's Age	-1.701**	-0.0139**	-0.0120**
	(-5.77)	(-4.48)	(-5.69)
Child's Age-Square	0.0452**	7.79E-05	0.000235**
	(3.61)	(0.59)	(2.63)
SES: Education Level	1.777	-0.0192	-0.0122
Middle/High School	(1.10)	(-1.13)	(-1.06)
	6.966**	0.0549*	0.0599**
College and Above	(2.40)	(1.80)	(2.90)
Child's Age * SES			
*Age*Middle/High School*	-0.198	0.00113	0.000297
	(-1.49)	(0.81)	(0.31)
*Age*College and Above*	-0.205	-0.00175	-0.00427**
	(-0.83)	(-0.67)	(-2.43)
Male	0.814*	0.0229**	0.0179**
	(1.65)	(4.41)	(5.07)
Urban Status	1.972**	0.0241**	0.00436
	(3.39)	(3.93)	(1.05)
Father's BMI	1.238**	0.00697**	0.00329**
	(15.28)	(8.16)	(5.71)
Mother's BMI	1.571**	0.00898**	0.00296**
	(18.03)	(9.78)	(4.76)
Father's Smoking	0.609	-0.00657	-8.24E-05
	(1.10)	(-1.12)	(-0.02)
Mother's Smoking	-0.543	-0.0119	-0.0119
	(-0.31)	(-0.64)	(-0.95)
Father's Drinking	-0.858	0.00236	0.000538
	(-1.53)	(0.40)	(0.13)
Mother's Drinking	1.053	-0.00281	-0.00821
	(1.34)	(-0.34)	(-1.47)
Constant	-1.582	-0.106**	-0.018
	(-0.38)	(-2.41)	(-0.61)
N	12098	12098	12098
R-sqrd	0.139	0.089	0.064

Note:
1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

2.7.2 Logistic Regression Results of the Effects of SES on Child's Weight Status

Table 2.6 shows logistic regression results examining the impact of SES on overweight status and obesity, respectively. In Columns (1) and (3) SES is measured by parental education level. Columns (2) and (4) show the results using household income as SES. The results are similar as the ones using a linear probability model. Child's age has a negative impact on child's weight. Having college and above education increases the likelihood of having an overweight or obese children. Specifically, parent having college and above education increases the log odds of having an overweight child by 0.353. Males have higher prevalence of childhood overweight and obesity. Living in urban area also elevates the likelihood of having an overweight or obese child. Parents' BMI have significantly positive impact on child's weight as well.

Table 2.6: Logistic Regression Results Using Education and Household Income as SES Respectively, CHNS, 1991-2011

	(1)	(2)	(3)	(4)
	Overweight	Overweight	Obesity	Obesity
Child's Age	-0.0361	-0.0351	-0.005	-0.00479
	(-1.08)	(-1.05)	(-0.09)	(-0.09)
Child's Age-Square	-0.00612**	-0.00618**	-0.0122**	-0.0122**
	(-3.45)	(-3.48)	(-3.87)	(-3.85)
SES: Education Level				
Middle/High School	0.0147		-0.151	
	(0.16)		(-1.12)	

College and Above	0.353**		0.21	
	(2.45)		(0.99)	
SES: Household Income (in 000')		0.00145		-0.000547
		(1.18)		(-0.34)
Male	0.291**	0.285**	0.517**	0.512**
	(4.45)	(4.36)	(5.17)	(5.13)
Urban Status	0.319**	0.357**	0.18	0.220**
	(4.41)	(5.09)	(1.61)	(2.08)
Father's BMI	0.0822**	0.0838**	0.0569**	0.0587**
	(7.43)	(7.62)	(3.63)	(3.75)
Mother's BMI	0.0972**	0.0939**	0.0676**	0.0642**
	(9.36)	(9.11)	(4.61)	(4.42)
Constant	-5.818**	-5.647**	-5.715**	-5.604**
	(-13.41)	(-13.31)	(-9.48)	(-9.54)
N	12311	12311	12311	12311
Pseudo R-sqrd	0.134	0.133	0.168	0.166

Note:

1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

2.7.3 OLS Estimates Stratified by Gender, Urban/Rural Status and Wave

2.7.3.1 Gender

Figure 2.5 and Figure 2.6 illustrates the gender difference in overweight prevalence and it is clear that the gender disparity changes over time period as well as over age. These two figures demonstrate three findings. First, boys generally have a higher overweight prevalence than girls. Second, the overweight prevalence increases from 1990s to 2000s. Third, the overweight prevalence decreases gradually as child ages. The gender difference is the key interest in this section. According to Chinese

National Youth Risk Behavior Surveillance 2005 Report, 4.3% of boys drink soft-drinks frequently, compared with 2.7% of females. 23.6% of girls try to lose weight through diet restriction, while only 9.1% of boys do. While 29.1% boys spend over two hours per day playing computer games, girls play less than half as much (Ji 2007). Moreover, as a child ages, there is a constantly diminishing trend of overweight prevalence for girls. In contrast, the drop in overweight percentage is not very obvious for boys from age 2 to 13. The gender disparity in overweight prevalence can be attributed to cultural, economic, behavioral and genetic factors. In contrast to western boys, Chinese boys might have different views of self-body images. According to Chinese cultures, boys do not have a strong negative view of being overweight. In contrast, Chinese girls prefer to be slim and they are more likely to restrict diet when they are above age 14.

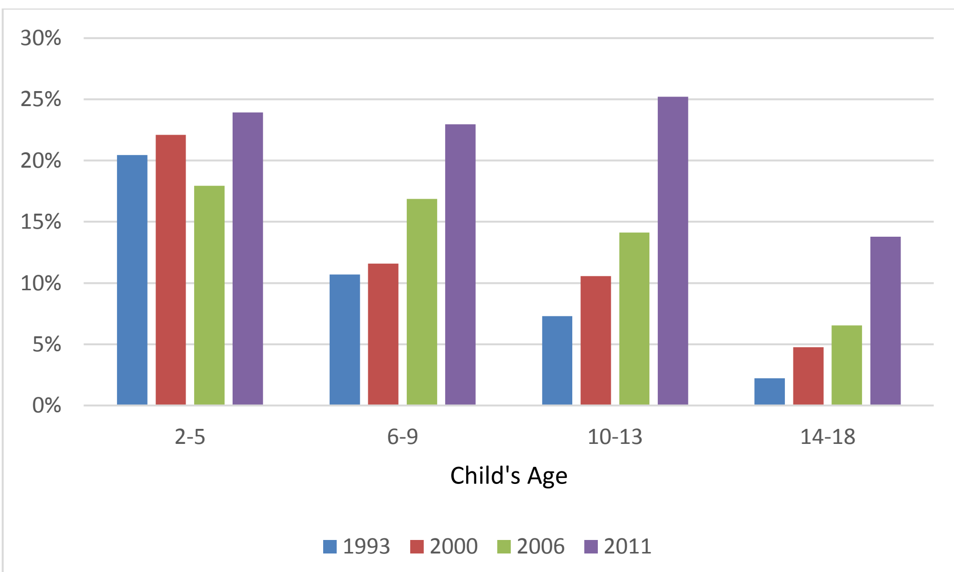

Figure 2.5: Age-specific Overweight Prevalence for Males, CHNS, 1993-2011

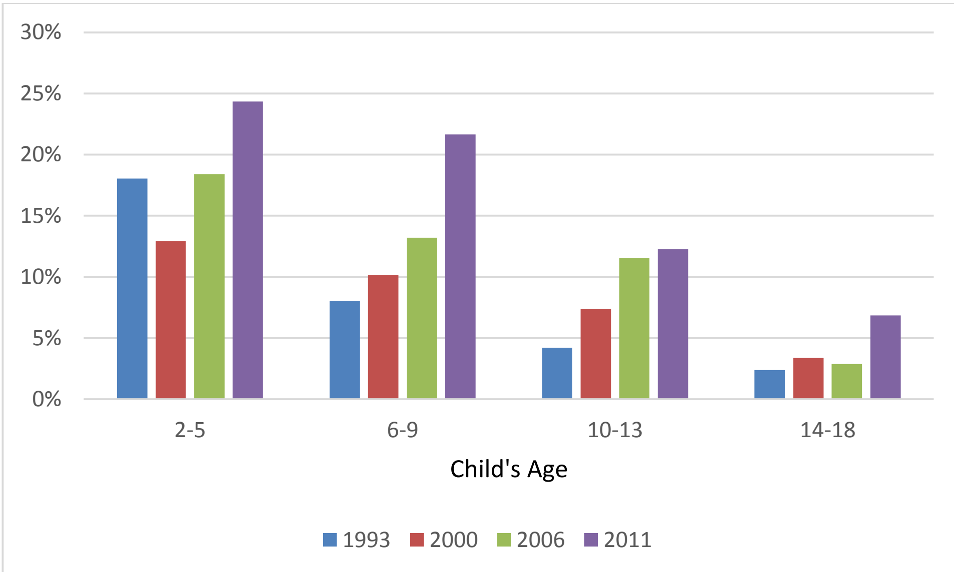

Figure 2.6: Age-Specific Overweight Prevalence for Females, CHNS, 1993-2011

In Table 2.7, I present OLS estimates when males and females are examined separately. I focus on the models with the age x SES interaction and I examine all three outcomes (BMI percentile, overweight, and obese). The estimates from the age-squared term suggest that the negative effect of age diminishes as age increases for females, and the nonlinear effect of age is more pronounced for females than for males.

SES has stronger and more consistent influence on child's weight for girls than for boys, especially for overweight and obesity prevalence. In a high SES family, a girl has a 7.16 percentage point increase in the probability of being obese but the effect declines modestly with age (see Column 6). However, the SES impact is barely significant for boys (Column 3). Mother's BMI has no impact on girls' obesity, with and without controlling for age*SES interaction effects. Meanwhile, father's BMI play a larger role in affecting girls' obesity prevalence compared with that for boy. Urban residence affects boys more in terms of increasing the BMI ranking as well as the likelihood of being overweight.

Table 2.7: OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity by Gender, CHNS, 1991-2011

	Males			Females		
	BMI	Overweight	Obesity	BMI	Overweight	Obesity
Child's Age	-0.660*	-0.0123**	-0.0117**	-2.952**	-0.0167**	-0.0125**
	(-1.65)	(-2.84)	(-3.83)	(-6.95)	(-3.83)	(-4.58)
Child's Age-Square	-0.0295*	-9.39E-05	0.000166	0.129**	0.000285	0.000318**
	(-1.73)	(-0.51)	(1.27)	(7.22)	(1.55)	(2.77)
SES: Education Level						
Middle/High School	-1.12	-0.0418*	-0.0214	3.940*	0.000305	-0.00306
	(-0.52)	(-1.80)	(-1.30)	(1.68)	(0.01)	(-0.20)
College and Above	5.556	0.0237	0.0437	8.033**	0.0821**	0.0716**
	(1.37)	(0.54)	(1.41)	(1.99)	(1.98)	(2.76)
Child's Age * SES						
*Age*Middle/High School*	0.22	0.00359*	0.00104	-0.558**	-0.00094	-0.000414
	(1.23)	(1.85)	(0.76)	(-2.91)	(-0.48)	(-0.34)
*Age*College and Above*	0.13	0.0016	-0.00338	-0.527	-0.00454	-0.00491**
	(0.37)	(0.42)	(-1.27)	(-1.54)	(-1.29)	(-2.24)
Urban Status	2.855**	0.0300**	0.00	1.31	0.01	0.01
	(3.58)	(3.49)	(0.00)	(1.62)	(1.64)	(1.35)
Father's BMI	1.042**	0.00618**	0.00284**	1.575**	0.00865**	0.00406**
	(10.33)	(5.66)	(3.68)	(11.78)	(6.30)	(4.74)
Mother's BMI	1.584**	0.0108**	0.00499**	1.545**	0.00661**	0.00057
	(13.22)	(8.31)	(5.45)	(12.57)	(5.24)	(0.72)
Constant	2.451	-0.0959	-0.0415	-7.85	-0.104	0.0277
	(0.45)	(-1.63)	(-1.00)	(-1.28)	(-1.64)	(0.70)
N	6591	6591	6591	5720	5720	5720
R-sqrd	0.151	0.096	0.070	0.141	0.081	0.060

Note:

1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

2.7.3.2 Urban/Rural Residence

Table 2.8 summarizes the results for urban/rural-stratified subsamples, again focusing on the models with the age x SES interaction and I examine all three outcomes (BMI percentile, overweight, and obese). Urban and rural residents in China lead very different lifestyles. Urban people have more access to Western-style food. Since they do not produce their own food any more, they reduce their consumption of fresh vegetables and fruits. Furthermore, the advancement in transportation leads to less physical activities in the urban area. Results from econometric estimates below show several findings.

First of all, age plays a different role. For urban children, the effect of age is negligible, especially after controlling for age*SES interaction. However, for rural children, age is consistently important for child's weight change. BMI ranking declines rapidly at first as child ages, but then less rapidly later. Secondly, SES has less impact on child's weight level for rural children. Fortunately, having middle/high school education will decrease the likelihood of have an overweight child. In contrast, high SES families from urban area have higher weight children. The difference in the relationship of SES and child's weight in urban and rural samples reflect different economic pressures as well. A wealth increase for rural families may lead them to have food that are nutritionally balanced and healthy, not necessarily of high fat and sugar. In contrast, in the urban families where the food is already plenty, the increase in wealth may lead to the purchase of Western style food. From the perspective of activity, wealth increase in the urban families might facilitate the purchase of TV and video game players, which elevates the probability of more sedentary activities for children at home. In contrast, the increase in income for rural families might be used to purchase items that satisfy basic needs. Thirdly, for parents' BMI levels, they both have significantly positive impact on child's weight for the rural families. However, for urban children, mother's BMI has no effect on the obesity prevalence. Fourthly, for the age*SES interaction term, it plays no role for the rural children. However, for the urban children, the SES disparities narrow with age for BMI ranking and the obesity prevalence.

Table 2.8: OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity by Urban/ Rural Residence, CHNS, 1991-2011

	Urban			Rural		
	BMI	Overweight	Obesity	BMI	Overweight	Obesity
Child's Age	0.109	-0.0033	-0.00413	-2.328**	-0.0174**	-0.0141**
	(0.18)	(-0.48)	(-0.92)	(-6.91)	(-5.07)	(-6.01)
Child's Age-Square	-0.0349	-0.000388	-5.01E-05	0.0739**	0.00023	0.000324**
	(-1.47)	(-1.43)	(-0.28)	(5.08)	(1.55)	(3.19)
SES: Education Level						
Middle/High School	6.288	0.0159	0.0123	0.617	-0.0255	-0.0151
	(1.58)	(0.35)	(0.42)	(0.35)	(-1.43)	(-1.24)
College and Above	13.40**	0.122**	0.0861**	-0.43	-0.02	0.04
	(2.75)	(2.20)	(2.39)	(-0.09)	(-0.40)	(1.13)
Child's Age * SES						
*Age*Middle/High School*	-0.366	0.000399	-0.00136	-0.147	0.00131	0.000442
	(-1.17)	(0.11)	(-0.59)	(-1.00)	(0.88)	(0.43)

*Age*College and Above*	-0.676*	-0.00547	-0.00697**	0.549	0.00384	-0.00218
	(-1.74)	(-1.24)	(-2.42)	(1.32)	(0.90)	(-0.75)
Male	2.089**	0.0387**	0.0129*	0.22	0.0177**	0.0205**
	(2.20)	(3.58)	(1.83)	(0.38)	(3.05)	(5.15)
Father's BMI	1.797**	0.0134**	0.00883**	1.062**	0.00520**	0.00174**
	(10.29)	(6.76)	(6.82)	(11.75)	(5.65)	(2.75)
Mother's BMI	1.232**	0.00888**	0.00156	1.672**	0.00876**	0.00335**
	(7.43)	(4.71)	(1.27)	(16.58)	(8.52)	(4.76)
Constant	-14.40*	-0.290**	-0.118**	1.42	-0.0867	-0.0503
	(-1.83)	(-3.25)	(-2.03)	(0.25)	(-1.50)	(-1.27)
N	3405	3405	3405	8906	8906	8906
R-sqrd	0.135	0.094	0.073	0.142	0.089	0.067

Note:
1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

2.7.3.3 Changes by Decades: 1990s and 2000s

Table 2.9 presents estimates of SES on BMI, overweight status and obesity separately for the 1990s and 2000s, respectively. Child's age has a negative impact on child's weight for both of the time periods although how age plays the role is different. For example, during 1990s, age has a negative impact on child's weight status, and the effect declines as the child ages. However during 2000s, the impact of age on child's weight status (BMI ranking, overweight status and obesity) is mixed. For SES, in the 2000s the role of high SES is dominant in increasing child's weight. In contrast, the effect of SES on child's weight in 1990s is much smaller. Having a middle/high school education compared with no education/primary education actually reduces child's weight. This result is contradictory to the preceding findings with the following possible reason. The SES increase due to having a middle/high education in

1990s may enable children to have food that is more nutritionally balanced and healthy, not necessarily of high fat and sugar.

In 2000s, China begins to enjoy more economic prosperity and engage more in the globalization. High SES families are more likely to have access to the western style food compared with low and median SES families. Therefore, high SES has a stronger influence in child's weight. Without controlling for age and SES interaction effect, parent having a college degree and above increases child's BMI ranking by 8.649. After controlling for the interaction effect, the impact further increases to 13.01. SES plays a different role in influencing child's weight in the 1990s and 2000s, which suggests the importance of the external socio-economic environment. In 2000s, China has ever increasing economic disparities, where high SES families get the access to western lifestyles. Therefore, high SES could exert more influence on child's weight through high fat food and easy transportation. In contrast, in 1990s, different SES groups lead similar lifestyles, thus high SES could hardly lead to child's weight increase.

Table 2.9: OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity by Decade, CHNS, 1991-2011

	1990s			2000s		
	BMI	Overweight	Obesity	BMI	Overweight	Obesity
Child's Age	-3.400**	-0.0238**	-0.0157**	0.706	-0.00193	-0.00818**
	(-9.38)	(-6.61)	(-6.67)	(1.40)	(-0.34)	(-2.06)
Child's Age-Square	0.115**	0.000489**	0.000395**	-0.0570**	-0.000446*	3.86E-05
	(7.40)	(3.16)	(3.92)	(-2.77)	(-1.91)	(0.24)
SES: Education Level						

Middle/High School	-2.339	-0.0487**	-0.0298**	7.378**	0.0154	0.00595
	(-1.27)	(-2.67)	(-2.50)	(2.28)	(0.42)	(0.23)
College and Above	4.67	0.06	0.04	13.01**	0.07	0.0681**
	(1.00)	(1.34)	(1.28)	(2.99)	(1.38)	(1.98)
Child's Age * SES						
*Age*Middle/High School*	0.054	0.00399**	0.00201**	-0.44	-0.00168	-0.00108
	(0.35)	(2.61)	(2.01)	(-1.64)	(-0.55)	(-0.51)
*Age*College and Above*	-0.389	-0.00352	-0.00333	-0.383	-0.00177	-0.00422
	(-0.98)	(-0.90)	(-1.30)	(-1.04)	(-0.42)	(-1.44)
Male	-0.137	0.0145**	0.0106**	2.011**	0.0356**	0.0304**
	(-0.23)	(2.42)	(2.70)	(2.46)	(3.84)	(4.70)
Urban Status	1.414**	0.0177**	0.000905	2.851**	0.0313**	0.01
	(1.98)	(2.50)	(0.20)	(3.02)	(2.91)	(1.36)
Father's BMI	1.636**	0.00671**	0.00231**	1.009**	0.00713**	0.00375**
	(12.61)	(5.21)	(2.75)	(9.63)	(5.99)	(4.53)
Mother's BMI	1.529**	0.00728**	0.00209**	1.566**	0.0103**	0.00379**
	(13.32)	(6.40)	(2.81)	(11.97)	(6.94)	(3.67)
Constant	-9.677**	-0.0562	0.0516*	-12.75**	-0.209**	-0.0746
	(-2.26)	(-1.32)	(1.85)	(-2.14)	(-3.08)	(-1.59)
N	7481	7481	7481	4830	4830	4830
R-sqrd	0.131	0.073	0.045	0.154	0.097	0.078

Note:
1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. For the 1990s subgroup, the reference levels for education level, wave and location are no education/primary education, 1991 and Liaoning respectively. For the 2000s subgroup, the reference levels for education level, wave and location are no education/primary education, 2000 and Beijing respectively.

2.7.4 Quantile Regression Results

Compared with OLS regression results, the use of the quantile regression method offers a more complete picture of the relationship between child's weight and other important attributes. Table 2.10 shows the estimated effects of SES and other important variables on child's BMI at the 5%, 25%, 50%, 75% and 95% for the total population ranked by BMI ranking. The effect of child's age is only significant at higher quantiles, implying that it has significant impact for heavier children. For the SES as proxied by parents' education level, the effect of high SES on child's weight is mostly positive, suggesting that higher SES families tend to have higher weight children. At the upper 95% tail of BMI ranking, the effect becomes negative, although insignificant, suggesting higher education could help cope with childhood obesity to some extent. For the age*SES interaction term, the effect varies at different quantiles. For parents' BMI level, it consistently has significantly positive impact on child's weight across the whole distribution.

The findings suggest several things: 1) The impacts of child's age are largely different across BMI distribution, where the effect of age is more pronounced in the upper tails than in the lower tails; 2) There exists a certain pattern for SES as well. The impact of SES is larger for overweight children. Although insignificant, it helps to fight obesity. 3) Parents' BMI levels are key risk factors for child's weight increase throughout the whole BMI distribution.

In addition, Table 2.11 reports some of the formal test results for the equality of the coefficients for some particular regressors. The null hypothesis is that the effects of the certain regressor (e.g. mother's BMI) are the same at two different quantiles (e.g. 5% and 25%). The prob.>F value is 0.0005, which is smaller than 0.01. Therefore, I could reject the null hypothesis at 1% significance level and conclude that the effects of mother's BMI are not the same at 5% and 25% quantiles. Notably, I find that for the comparison between 5% and 95% quantiles, all of the p-values are less than 0.01, implying that the effects of these regressors at the lower and upper portion of children's BMI ranking are very different. In contrast, for some other comparisons (e.g. 50% vs. 95%), the effect of certain regressor (e.g. urban status) does not vary significantly. In sum, these findings suggest that it is important to heed the heterogeneity of these effects along the BMI distribution.

Table 2.10: Quantile Regression Results for BMI Percentile Ranking, Children Ages 2 to 18, CHNS, 1991-2011

	(1)	(2)	(3)	(4)	(5)
	5%	25%	50%	75%	95%
Child's Age	0.13	-0.188	-2.492**	-3.483**	-1.834**
	(0.77)	(-0.52)	(-5.56)	(-7.44)	(-4.32)
Child's Age-Square	-0.00383	-0.0017	0.0844**	0.109**	0.0155
	(-0.53)	(-0.11)	(4.44)	(5.46)	(0.86)
SES: Education Level					
Middle/High School	0.264	0.16	3.282	2.824	-1.525
	(0.29)	(0.08)	(1.34)	(1.11)	(-0.66)
College and Above	1.336	7.412**	11.41**	10.54**	-3.889
	(0.80)	(2.08)	(2.59)	(2.29)	(-0.93)
Child's Age * SES					
*Age*Middle/High School*	-0.0335	-0.105	-0.284	-0.361*	0.143
	(-0.44)	(-0.64)	(-1.41)	(-1.71)	(0.75)
*Age*College and Above*	(0.03)	-0.336	-0.553	-0.622	0.605*
	(-0.20)	(-1.11)	(-1.47)	(-1.58)	(1.70)
Male	-0.593**	0.17	0.80	0.91	1.245*
	(-2.09)	(0.29)	(1.06)	(1.16)	(1.75)
Urban Status	0.31	1.336*	1.463*	3.053**	1.984**
	(0.94)	(1.89)	(1.67)	(3.34)	(2.39)
Father's BMI	0.183**	1.476**	2.073**	1.973**	0.963**
	(3.94)	(14.82)	(16.81)	(15.32)	(8.25)
Mother's BMI	0.250**	1.375**	2.134**	1.866**	0.568**

	(5.01)	(12.90)	(16.16)	(13.53)	(4.54)
Constant	-3.768	-24.68**	-25.29**	1.67	66.66**
	(-1.59)	(-4.87)	(-4.03)	(0.25)	(11.21)
N	12311	12311	12311	12311	12311
Pseudo R-sqrd	0.013	0.061	0.092	0.111	0.090

Note:

1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) Wave dummies and location dummies are included in the quantile regression. For full set of regression result, please refer to the appendix. The reference levels for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

Table 2.11: Test for Equality of Some Regressors' Coefficients across Quantiles, CHNS, 1991-2011

	Prob>F			
Regressor	5% vs. 95%	25% vs. 95%	50% vs. 95%	75% vs. 95%
Mother's BMI	0.0005	0.0000	0.0000	0.0000
Urban Status	0.0010	0.4486	0.6777	0.1771
Child's Age	0.0000	0.0038	0.2707	0.0002
Male	0.0088	0.1962	0.5499	0.6846

Note: the numbers in the tables are the p-values. If the p-value is less than 0.01, it suggests that one can reject the null hypothesis and conclude the effects of the certain regressor at these two quantiles are not the same.

2.8 Concluding Remarks

This research contributes to the literature by investigating the impact of SES on child's weight changes and how the SES-weight gradient differs with age, gender and urban status. The results show that BMI ranking and overweight status/obesity prevalence drops as children transition from two-years old to 18 years old. After controlling for the age and SES interaction effect, BMI ranking decreases by 1.881 per year of age, while the prevalence of overweight status and obesity decreases by 1.27 and 1.19 percentage points per year of age.

Child's weight is positively correlated to SES and the weight disparities due to SES generally decrease with age. The primary proxy for SES in this study is parents' highest education level. The econometric results show that having college and above education has a significantly positive impact on child's weight increase. For SES, the stronger and more consistent result from the estimates is the influence of parent having a college degree or higher on the likelihood of a child having a higher weight. For high SES group compared with median SES group, BMI ranking increases by 4.557. And the prevalence of overweight status and obesity increase by 3.88 and 1.51 percentage points respectively. The examination of the possible mechanism of parents' health behaviors (drinking and smoking) though which SES affects child's weight shows that the difference of the SES impact is quite small after parents' health behaviors (drinking and smoking) are controlled for, implying little effect of such parents' health behaviors through which SES plays a role.

I obtain more results after the full sample is stratified by child's gender, urban/rural status and survey years respectively. For the gender difference, the SES has less impact on males than on females, especially for obesity prevalence. For the urban/rural difference, SES has less impact on child's weight level for rural children. For the survey years, in the 1990s, SES as proxied by parents' education level has limited impact on child's weight. For a family with at least one parent having a middle/high education level compared with no education/primary education is predicted to have lower weight children. In contrast, in the 2000s, the higher the parents' education level, the more likely their children are having more weight.

The results from the stratified analysis suggest primarily two things for the impact of high SES on obesity prevalence: 1) high SES plays more role for urbanized people; 2) high SES has more impact in 2000s'. It is tempting to infer that the rise of childhood obesity, especially in the urban area and among high SES families in China might be attributed to the globalization beginning in the 2000s which modifies the culture of calorie intake and energy expenditure. The western post-industrial food systems constantly provide energy-dense food through supermarket and fast food chain. Physical activities are also minimized through increasing trend of automobile traveling, video-gaming and TV watching. Therefore, industrialized food system, vehicles and entertainment, together with the western cultures are the probably causes of the ever increase in childhood obesity.

Urban area has more western-style food chains and better public transportation systems, so that the high SES families have more access to the high-calorie food and more likely to have a sedentary lifestyles. Therefore, SES has more significant impact on child's weight for the urban families compared with their rural counterparts. In contrast, in U.S., there might not be such rural-urban difference due to the well-developed food distribution system.

The results suggest the plausible explanation for SES-weight relationship difference in developed countries like U.S. and developing countries like China. The reason is that the influence of SES on diet and physical activities for two countries might be different. In the U.S., the energy-dense diets are more affordable compared with the diets such as lean meats, fish, vegetables and fruit. Therefore, those low SES groups have to buy relatively low cost of energy-dense food in order to satisfy caloric requirements, leading to higher chance of being obese. In contrast, Chinese rich people have more access to the western style food which is energy-dense and much more expensive than other foods such as vegetables and fruits.

However, unlike U.S., China is not fully globalized, where only high SES families are incorporated into global system. Fast food chains and mass transportations only exist in urban areas. Therefore, low SES individuals are still localized and may not have enough nutrition, resulting in large urban-rural difference in childhood obesity. Moreover, children and adolescents are more likely to be attracted by western culture and adjust their eating and activity behaviors accordingly. Therefore, we could observe a rise in childhood obesity, but the rise is not apparent for the adults.

The results indicate the need of considering gender-specific, age-specific and urban/rural-specific approaches in developing intervention strategies of child weight increase in China. In general, I suggest offering more health education to children as well as their parents about the risk of obesity. While it is difficult to reject globalization, the society as a whole needs to transform their traditional view of childhood obesity, beware of children's obesity-related eating behaviors and urge the children to increase more physical activities.

Chapter 3

PARENTAL BMI AND CHILD'S WEIGHT

3.1 Introduction

In this chapter, I estimate the intergenerational transmission of BMI using the China Health and Nutrition Survey (CHNS) data from 2004-2011. In recent decades, the rapid economic growth in China is accompanied by a weight increase in children, which might be caused by profound changes in society and in behavioral patterns due to nutrition transition and globalization. In spite of the nurturing effect, it is also interesting to investigate whether weight is transferred across generations, and to explore the roles of other factors in the weight transfer. The results of intergenerational transfer might help us understand whether the increase in child's weight is partially due to the increase in adult's weight. If a high correlation between parents' and children's weight outcomes is observed, it suggests that same factors leading to parents' weight increase might explain part of the increase in children's weight, such as the genetic factors, the same unfavorable environment, or the food choices determined by parents. On the other hand, if the correlation between parents' and children's weight outcomes is low, it might suggest that there are some other factors that determine children's weight outcomes. Furthermore, there might be differences in the correlation for different subgroups, such as males versus females, and urban versus rural children. The analysis of these disparities will potentially shed light on the policy implementation for China.

While previous studies have examined various causes of childhood obesity, very few have analyzed the intergenerational linkages. Although some of the previous research focused on the socio-economic factors influencing child's weight, they neglected the possibility that some omitted factors may be transmitted across generations (such as genetics). Genes are crucial in determining a person's susceptibility to weight change.

In this chapter, I investigate the intergenerational persistence of weight with several major goals. The first one is to explore how children's BMI is related to their parents' BMI, controlling for a myriad of variables, namely SES, demographic variables and environmental variables. I exploit the longitudinal nature of the dataset and use a panel data method to correct for unobserved heterogeneity in analyzing the intergenerational transmission of BMI. Secondly, I use the Blinder-Oaxaca decomposition to quantify the difference in child's BMI between urban and rural areas, since the urban and rural disparities are pronounced in terms of economic prosperity and health care access. To my best knowledge, this study provides the first evidence for the intergenerational transmission of BMI in China, and also the first one to investigate the BMI gap between urban and rural areas. I expect the results to have implications for policy implementation in China with the goal of addressing the ever increasing trend in childhood obesity.

3.2 Literature Review

For the study of intergenerational transmission, many researchers focus on the intergenerational relationship between parental and child's health. A myriad of factors have been identified such as genetics, culture, family values, shared environment and consumption choices (Doyle et al. 2009). Parents and children share a similar environment, therefore they can be affected by the similar factors. Moreover, parents can either directly or indirectly affect their children's health through health and nutrition styles. Furthermore, parents and children can be both influenced by some unobserved or unmeasured factors.

Ahlburg (1998) is one of the first researchers to analyze the intergenerational transmission of health outcomes. He reports the intergenerational correlation in lifespan with the estimates between 0.15 and 0.3. Coneus and Spiess (2012) employ the German Socio-Economic Panel data and examine the intergenerational relationships between parent and child health, using different health indicators. Their results show that parental health status is found to be transmitted to children through the mother. The intergenerational linkage is still significant after controlling for variables related to child, parent, and household information. Most of their findings are robust after accounting for unobserved heterogeneity.

Eriksson, Pan, and Qin (2014) use the China Health and Nutrition Survey (CHNS) data from 1991 to 2009 and estimate the intergenerational health transmission in China. They find correlation in health status between parents and children in urban areas as well as rural areas. They also argue that parents especially mothers' SES and health care choices are important in determining their own as well as their children's health. In addition, they find that 15% to 27% of the urban-rural disparity of child health is due to their parents' endowed inequality.

The literature reviewed above confirmed the importance of intergenerational health transmission. The intergenerational correlation of Body Mass Index (BMI), as another important measure of health capital, has also been studied. Martin (2008) uses US data and finds that children with both parents reporting to be obese have one standard deviation higher BMI levels than the sample mean. However, this study has a limitation of potential measurement error since parental height and weight are not collected, and only the responses of whether parents are obese or not are recorded.

Anderson et al. (2007) use US data to estimate the contemporaneous correlation of BMI between mothers and children at certain years. They provide evidence that the intergenerational BMI elasticity has increased over time from 1971 to 2004, but does not have significant variations for families with different income levels. They attribute the transmission of BMI to the interaction of sharing environments and genetic factors, with sharing environments playing more and more influential role over time.

Classen (2010) uses data from the National Longitudinal Survey of Youth 1979 (NLSY79) and the Children and Young adults of the NLSY79 (YA NLSY79), and provides evidence for the degree of dependence in BMI and obesity across generations during the time of obesity growth. Classen finds that the intergenerational BMI correlation of mother-to-daughter is 0.38 and the correlation is 0.32 for mother-to-son. He also finds that the strongest intergenerational persistence of BMI when mothers' BMI is highest, implying the transmission of weight problems for obese mothers is more severe. This transmission might negatively influence economic success for the next generation.

Abrevaya and Tang (2011) analyze the spousal and intergenerational relationship in BMI using a U.S. dataset that contains families' weight data as well as SES and behavioral control variables. They use two approaches to deal with possible endogeneity that results from omitted variables. They find the parental BMI is the most important predictor of the child's BMI.

3.3 Conceptual Framework

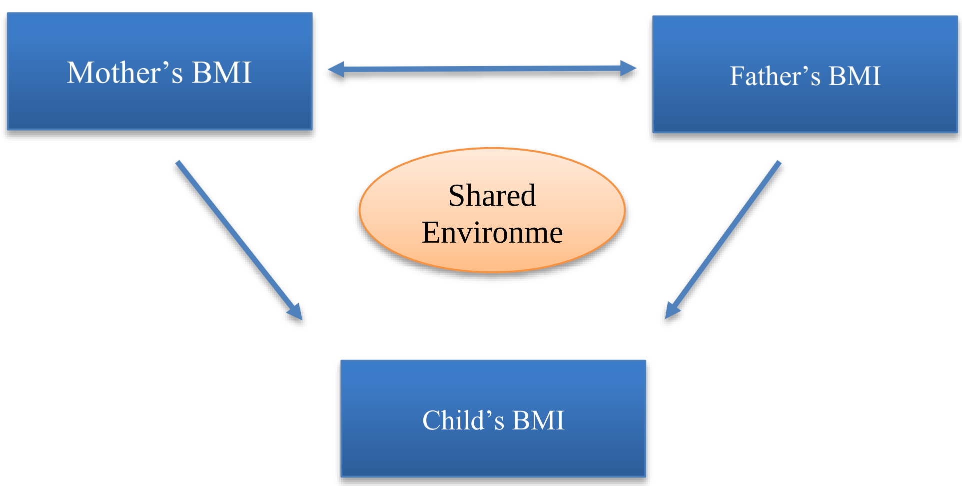

Figure 3.1: Familial BMI Correlations

Figure 3.1 shows the familial BMI correlations. A myriad of factors would account for the linkages in BMI for a family. First of all, husband and wife starts a family by matching, which might contain factors such as BMI matching. Therefore, it is highly possible that husband and wife have similar weight levels and body images. Second, there is a genetic component in BMI that carries over generations. Third, other than genetic factors, parents can influence their child's through other ways. For example, parents could invest in good nutrition and medical care at the fetal stage and avoid unhealthy behavior such as drinking and smoking. Fourth, parents and children share the same environment and could be assumed to have access to similar food and drinks. Fifth, there might be unobserved environmental factors that can result in correlations between parent and child's BMI.

3.4 Data Description

Similar to the second chapter, the data used here are from China Health and Nutrition Survey (CHNS), conducted by the Carolina Population Center and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. The sample surveyed is collected through a multistage and random cluster process. Firstly, nine provinces that vary substantially in terms of demographics, economic growth, and health resources are selected. Then in each province, counties were firstly stratified by income and four counties are then randomly selected. In addition, two cities in each province are included in the sample as well. If feasible, the capital in the province and a lower income city are selected. Furthermore, in each county/city, communities are randomly selected as primary sampling units which largely represent villages/townships for counties and urban/suburban neighborhoods for cities.

In the second chapter, I only utilize the household and individual information, which relates to individual's socio-demographic characteristics and health status. In this chapter, I also use the community-level information in order to control for environmental impacts. The community-level information of each primary sampling unit is provided in separate questionnaires with information from a knowledgeable respondent on community infrastructure (e.g. water, transportation, electricity, and communications), public services (e.g. health facilities), local food market prices, etc. Moreover, the CHNS data have a panel feature which allows for tracking changes in characteristics over time, thus providing better control for unobserved heterogeneity.

The newly added environmental information includes: whether the community has fast food restaurants; whether the community has private health care for children less than 3 years old; whether the community has private health care for children 3-6 years old. After the data merging and cleaning, 3,102 observations are included in the sample used for this chapter, since the above mentioned community information is only collected in the recent waves (e.g. 2004, 2006, 2009 and 2011). In the final edited sample, the numbers of communities in the waves of 2004, 2006, 2009 and 2011 are 186, 184, 176 and 236 respectively. Descriptive statistics for the sample I use are reported in Table 3.1.

Table 3.1: Descriptive Statistics by Wave, CHNS, 2004-2011

	2004	2006	2009	2011
Child's BMI Percentile	42.4	41.4	40.9	50.6
Parents' Education Level				
No Education/Primary School	13.7%	14.5%	14.7%	8.7%
Middle/High School	79.1%	75.6%	75.5%	68.2%
College and Beyond	7.3%	10.0%	9.8%	23.2%
Child's Age	10.9	10.5	9.9	9.6
Mother's BMI	22.9	23.1	23.3	24.4
Father's BMI	22.6	22.7	22.8	23.2
Household Income	19158.7	23290.3	35939.2	53874.1
% Male	53.8%	54.5%	59.4%	54.7%
% Urban	27.4%	27.6%	25.5%	38.9%
Environmental Variables				

% With Private Child Care for <3 yr Children	25.1%	27.7%	30.8%	32.6%
% With Private Child Care for 3-6 yr Children	53.9%	65.0%	65.5%	58.8%
% With Fast Food Restaurant in the Community	11.8%	12.9%	23.4%	38.9%
# of Observations	879	692	620	911

Note:

1) The unit of household income is Renminbi. The exchange rate has the range of 0.12-0.16 US dollar per Renminbi from 1990-2015.
2) Using 2004 as the base year, the household income has been adjusted for inflation, thus it is the real household income.

Table 3.1 reports the summary statistics for the key variables in the 2004-2011 waves. The child's BMI percentile is relatively stable from 2004 to 2009, but it jumps in 2011. Part of the reason is contributed to the fact that three province-level municipalities (Beijing, Chongqing and Shanghai) were added in 2011. These three cities have better economic performance and are a comparatively more prosperous population. Children in these cities have comparatively higher weight than the rest of China[8]. For example, for cities like Beijing and Shanghai, the obesity rate is around 15% while for a province like Guangxi, the obesity rate is only 1%. However, the high obesity rate in Beijing and Shanghai might be an indication of what the obesity rate in the rest of China could be as it becomes more developed in the future.

The BMI levels of parents are relatively stable. The percentage of population living with fast food restaurants in town increases from 11.8% in 2004 to 38.9% in 2011. Child care facilities for children less than 3 years old have become more common, with the percentage increasing from 25.1% to 32.6%. The percent of having private childcare in the community for 3-6 year old children gradually increases from 2004 to 2009, but it declines from 65.5% in 2009 to 58.8% in 2011. The reason from

8 I control for location information in my analyses.

the data point of view is that the sample of newly added cities have lower percentages of childcare facilities. For the sample containing only three cities, the percentage of having private childcare in the community for 3-6 year old children is only 50.3%. Now we may wonder why the cities have low percentage of private childcare facilities in the community. The reason is because of the different community schemes in rural and urban. For the rural, villages and townships are treated as communities and the community itself does usually have childcare facilities since the village/township is more likely to have everything and rural people can satisfy their needs within this community. However, for the urban, urban/suburban neighborhood is treated as communities, therefore, it is more likely that it does not have the childcare facilities nearby. The childcare might be set in another neighborhood.

In terms of the socio-economic variables, average annual household income is 19,158 yuan in 2004, but it improves substantially to 53,874 yuan in 2011. For the parental education variables, we can see a slightly decline in the percentage of middle/high school education group through 2004 to 2009. The declined portion largely shifts towards the high SES group. In 2011, we can see a relatively large change in the SES shares because of the newly added cities. Big cities usually have more high SES group, and relatively less mid SES and low SES groups. Part of the improvement is again due to the inclusion of observations from Beijing, Shanghai and Chongqing. Notably, I have 338 observations from the three big cities included in the 2011 wave. Beijing, Shanghai and Chongqing are named as cities, but they are more like more developed “provinces” (or municipalities). I find that people there are not necessarily all urban population. 145 out of 338 observations are rural. In spite of this, their urban% is much greater than the other provinces (e.g. 27%) included in the sample. Moreover, the rural area of these big cities are economic prosperous as well.

3.5 Econometric Method and Estimation

3.5.1 Measures of Intergenerational BMI Elasticities

The intergenerational BMI elasticity is derived from a regression model shown in the following equation:

(3.1) $\ln BMI_{ij(g+1)} = \beta_0 + \beta_1 lnBMI_{jg} + \varepsilon_{ij(g+1)}$

where $\ln BMI_{ij(g+1)}$ is the natural logarithm of child i's BMI ranking from family j in generation g+1, and in the same way $lnBMI_{jg}$ is the natural logarithm of the mother's BMI from family j in generation g. β_1 represents the intergenerational elasticity of a child's BMI ranking with respect to the mother's BMI. If the elasticity is calculated as zero, it indicates there is no persistence in weight between generations. I will provide estimates of the intergenerational elasticities of weight between mothers and children for the full sample as well as the results by gender, urban status and SES level.

3.5.2 Benchmark Model

I start with a benchmark model to describe the intergenerational transmission of BMI, conditional on other influencing factors, using an econometric specification similar to that in Eriksson, Pan, and Qin (2014):

(3.2) $BMI_{Cit} = \alpha_0 + \alpha_1 BMI_{Mit} + \alpha_2 BMI_{Fit} + \theta DV_{it} + \mu SES_{it} + \vartheta EV_{it} + \mu_{it}$

In equation (3.2), the outcome variable is the BMI ranking (non-log form) of child i at time t. BMI_{Mit} and BMI_{Fit} represent mother's and father's BMI at time t. DV_{it} represents demographic variables such as child's age, gender, urban/rural status, location dummies (Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou, Chongqing and Beijing) and survey year dummies (2004, 2006, 2009 and 2011). SES_{it} contains a household's socio-economic information (e.g. parents' educational attainment). EV_{it} contains dummy variables, which controls for environmental impact, such as whether the community has fast food restaurant, and whether the community has child care facilities . μ_{it} is the random error term that varies with individual and year. I will provide estimated results for the full sample as well as urban/rural subsamples.

3.5.3 Panel Data Method

A common issue in health-related studies arises from the fact that the key explanatory variables such as maternal employment and occupational choices are endogenous, leading to either upward or downward bias in coefficient estimates. The endogeneity is widely known due to three reasons: 1) omitted variables in the estimation equation; 2) reverse causality; and 3) possible measurement error in the variables. In this study, reverse causality is not likely an issue since children's BMI is not likely to influence parents' BMI. Measurement error in BMI is also not an issue since weight and height are measured through on-site physical examinations. However, the benchmark model above may suffer from omitted variable bias due to unobserved factors affecting both parents' and child's weight outcomes. These unobserved factors mostly fall into two categories: inheritable genetic characteristics and environmental factors. Genes are the most natural endowments that are transmitted between generations, resulting in similar traits of heights and weights between parents and child. These inheritable genetic factors are important to predict children's weight and height. However, they cannot be measured and included in the regression model. Moreover, family members in the same household have similar exposures to the environment and share similar lifestyles. Some of these factors are unobservable from the survey, such as polluted water, which simultaneously influence both parents and children's height and weight.

Failing to account for these unobserved factors might lead us to over-estimate or under-estimate the impact of the explanatory variables. Fortunately, many of the characteristics mentioned above are individual-specific and time-invariant, therefore panel data methods can be employed to account for these sources of unobserved heterogeneity. The model can be re-specified as follows:

(3.3) $BMI_{Cit} = \alpha_0 + \alpha_1 BMI_{Mit} + \alpha_2 BMI_{Fit} + \theta DV_{it} + \mu SES_{it} + \vartheta EV_{it} + \upsilon_{i(t)} + \mu_{it}$

The added term $\upsilon_{i(t)}$ represents the unobserved individual-specific heterogeneity. In particular, if $\upsilon_{i(t)}$ is specified as υ_{it}, then this effect is assumed to be random and uncorrelated with the individual characteristics represented by the covariates. This specification allows the time-invariant variables (e.g. gender, urban status) to play a role as explanatory variables. Thus the total residual variance can be partitioned into two components: the between-entity variance υ_{it} and the within-entity variance μ_{it}. This is the random-effects model. If $\upsilon_{i(t)}$ is specified as υ_i, then this effect is assumed to be fixed and time-invariant. These time-invariant characteristics are unique to the individual. In that case υ_i may be correlated with the other included covariates. This specification removes the effect of time-invariant variables so one can assess the net effect of the covariates on the outcome variable. This is the fixed effects model. Since the unobserved heterogeneity is eliminated, the estimates are more accurate compared with estimates from equation (3.2).

The common approach in selecting between fixed-effects and random-effects models is to employ the Hausman test, which tells us how significantly parameter estimates differ between the two approaches. If the difference is not significant, then one is directed to use random-effects, as they are more efficient (use fewer degrees of freedom). However, if the difference is significant, then one is guided to use fixed effects for non-biased estimates.

In academic research, the fixed-effects model is used by many researchers, almost by default, on the basis that the assumption of the random-effects model is unrealistic. The main attraction for using fixed-effects model is that no assumption about υ_i is required. In this research, I decide to run both fixed-effects model and random-effects model, and perform Hausman test to check whether the estimates are significant different from each other.

3.5.4 Kernel Density Estimation

Kernel density estimation is a non-parametric procedure that can be used to estimate the probability density function of a random variable. In this section, I use this method to determine the BMI ranking distribution for different sub-groups, and make the corresponding comparisons (e.g. males vs. females, and urban children vs.

rural children). This method is a data-smoothing technique and inferences about the population distribution could be made based on a finite data sample. The kernel density estimate $\widehat{f_h}(x)$ is a univariate unknown density *f* based on a random sample ($x_1, \ldots x_n$), which was introduced by Rosenblatt (1956) and Parzen (1962). The shape of this function is of interest in the estimation. The kernel density estimator is

$$(3.4)\quad \widehat{f_h}(x) = \frac{1}{n}\sum_{i=1}^{n} K_n(x - x_i) = \frac{1}{nh}\sum_{i=1}^{n} K(\frac{x - x_i}{h})$$

where K(·) is the kernel which is a non-negative function that integrates to one. h>0 is the bandwidth, which is a smoothing parameter and critical issue in kernel density estimation. The bandwidth has a strong influence on the estimate. Ideally, one wants to choose h as small as possible, because if it is large, the estimated curve might obscure much of the underlying structure. However, there exists a trade-off between the variance of the estimator and its bias. If the bandwidth is too small, the estimated curve might contain too many spurious data. In this study, I use Silverman's rule of thumb (Silverman 1986) to calculate the optimal bandwidth.

$$(3.5)\ h = (\frac{4\widehat{\sigma^5}}{3n})^{\frac{1}{5}} \approx 1.06\hat{\sigma}n^{(-\frac{1}{5})}$$

where $\hat{\sigma}$ is the standard deviation of the sample. I calculate the bandwidth using this formula after getting the standard deviation and the number of observations for each sub-group. In my sample, the standard deviation and the number of observations for females are 30.60 and 1386 and for males are 32.25 and 1716 respectively. For the rural population, the standard deviation and the number of observations are 31.37 and 2158 respectively, while for the urban population, those numbers are 31.67 and 944 respectively. Therefore, the bandwidth is calculated as 7.71 for males, while for females it is 7.63. For the urban population, the calculated bandwidth is 8.53 while for the rural population, it is 7.16.

3.5.5 Blinder-Oaxaca Decomposition

The Blinder-Oaxaca decomposition technique is often used to analyze wage gaps by race or gender. It decomposes the wage difference between groups into two parts: one part that is explained by group differences in observed variables such as education level and work experience, and the other part that could not be captured by these differences. The second part is often referred as a measure of the discrimination for two groups.

In China, the urban and rural disparities are pronounced in terms of economic prosperity and health care access. Because Chinese government implement policies that are more favorable towards urban areas, the health care systems in urban areas are comparatively better than those in the rural areas. Moreover, because of the residential permit system (hukou), internal migration is largely restricted. Therefore, urban and rural residents in China are largely different in terms of dietary patterns, fast food availability, local sports facilities, etc. Liu, Fang, and Zhao (2013) find evidence that: 1) children in the urban areas are generally in better health status; 2) the difference in health and nutritional status between urban and rural areas has declined significantly during the period of 1989 to 2006; and 3) the gap in health care access between urban and rural has shrunk at the same time.

Although the urban and rural disparities decreased, the difference still exists and remains a concern. Therefore, I use the Blinder-Oaxaca decomposition to quantify the difference in child's BMI ranking between urban and rural areas. In light of a similar logic as the decomposition of wage difference, I decompose urban-rural disparity in child's BMI into two parts: the endowment effect (observed differences such as SES, living environments) and the remaining effect (unobserved differences due to urban/rural sectors).

The Blinder-Oaxaca decomposition technique quantifies the difference in child's BMI ranking between urban and rural areas as follows:

$$(3.6)\quad \overline{BMI_{Cu}} - \overline{BMI_{Cr}} = \widehat{\beta_u}\overline{X_u} - \widehat{\beta_r}\overline{X_r}$$

where the subscripts u and r denote urban and rural respectively, and the outcome variable is the difference of group means (child's BMI ranking) of urban and rural samples. The constant term is dropped for ease of exposition. X is a vector of observed characteristics (e.g. DV, SES, EV in equation 3.2). $\hat{\beta}$ is the associated coefficient vector. Equation (3.6) suggests that the difference in group means (child's BMI) of urban and rural samples could be either attributed to the difference in $\bar{X}$ or $\hat{\beta}$. The former implies the group differences in the observed characteristics, while the latter suggests the contribution of differences in the coefficients.

By adding and subtracting $\widehat{\beta_u}\overline{X_r}$, equation (3.6) can be rewritten as follows:

$$(3.7)\quad \overline{BMI_{Cu}} - \overline{BMI_{Cr}} = (\overline{X_u} - \overline{X_r})\widehat{\beta_u} + \overline{X_r}(\widehat{\beta_u} - \widehat{\beta_r})$$

The first term on the right hand side of equation (3.7) is the urban/rural difference in average values of observed variables multiplied by $\widehat{\beta_u}$. It shows the impact of differences in the means of the observables, if the means affected rural outcomes in the same way as they affect urban outcomes. The second term on the right hand side measures the BMI ranking differential due to the disparity in coefficients on the observables, which is referred to as the unexplained part of the BMI gap.

3.6 Empirical Results

3.6.1 Estimates of the Intergenerational Elasticities of BMI

The elasticity here is calculated as child's BMI percentile with respect to mother's BMI (equation 3.1). It refers to the degree of responsiveness in child's weight in relation to mother's weight change. Since the proxies of weight status for children and their mothers are their BMI rankings (scaled from 0-100) and BMI respectively, the elasticities do not fall into the 0-1 range. In spite of that, the estimates can still be indicators for the relative degree of persistence across generations.

Table 3.2: Intergenerational BMI elasticities for the Full Sample and Selected Subsamples, CHNS, 2004-2011

	Elasticity	Std. Error	Sample Size	R-squared
Full Sample	2.051	0.232	3102	0.025
Gender				
Males	1.576	0.324	1716	0.014
Females	2.642	0.330	1386	0.044

Urban Status				
Rural	1.968	0.279	2158	0.023
Urban	2.203	0.419	944	0.029
SES (Education Level)				
No Education/Primary School	3.127	0.650	390	0.056
Middle/High School	2.084	0.277	2307	0.024
College and Above	1.770	0.465	405	0.035

Table 3.2 provides my estimates of the intergenerational elasticities of BMI between mothers and children for the full sample as well as the results by gender, urban status and SES level. The estimated intergenerational elasticity of BMI is 2.051 for the full sample. This number indicates that if a mother's BMI is 10% higher, than a child's BMI percentile is 20.51% higher. For example, if a mother's BMI is 25 and a child's BMI ranking is 50 percentile, a 10% increase in mother's BMI would increase the child's BMI ranking to 60.3 percentile. The intergenerational correlation is higher among mothers and their daughters (2.642) than mothers and sons (1.576), which is consistent with findings from Classen (2010). The elasticities of BMI between mothers and children in the urban area and rural area are 2.203 and 1.968 respectively. The elasticities by education level indicate a greater persistence of BMI at lower education level. The elasticity is much larger in families with parent having no education or primary education. This implies that for the low SES families, weight problems may persist across generations. For the low SES parents, they are more likely to have underweight children and they cannot earn enough for their children to reach their underlying genetic weight disposition. This is probably because of inadequate nutrition that is common to parents and children. In contrast, for the high SES parents, they could have the ability to alter children's weight through nurturing.

3.6.2 Estimates of Benchmark Model

I start by looking at the results of the benchmark model. The models are estimated by OLS on the full sample, as well as on the urban and rural subsamples[9]. Because of large urban and rural disparities, it is important to analyze the intergenerational BMI separately for urban and rural subsamples.

Table 3.3: OLS Estimates of Effects on Children's BMI Ranking for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011

	Full Sample	Urban	Rural
Mother's BMI	1.674**	1.405**	1.777**
	(10.35)	(4.58)	(9.32)
Father's BMI	0.764**	1.718**	0.591**
	(6.42)	(5.45)	(4.61)
Child's Age	1.467**	3.250**	0.667
	(2.76)	(3.33)	(1.06)
Child's Age-Square	-0.117**	-0.191**	-0.0853**
	(-4.50)	(-4.08)	(-2.75)
Male	2.725**	5.232**	1.687
	(2.60)	(2.74)	(1.35)
Urban Status	0.304		
	(0.25)		
SES: Education Level			
Middle/High School	4.708**	13.94**	2.91
	(2.88)	(3.42)	(1.63)
College and Above	10.36**	17.06**	11.39**
	(4.42)	(3.74)	(3.60)
With Fast Food Restaurant	3.608**	1.007	5.934**
	(2.47)	(0.42)	(3.03)

[9] Because of the addition of the three big cities in the wave 2011, I also run the OLS regression after eliminating the observations from these three cities. The results are qualitatively similar as the results of the sample without this trimming.

With Child Care for <3 yrs Children	4.559**	-1.788	8.178**
	(3.31)	(-0.64)	(4.89)
With Child Care for 3-6 yrs Children	-0.709	4.619*	-3.647**
	(-0.54)	(1.72)	(-2.34)
Constant	-9.679	-39.82**	-5.079
	(-1.56)	(-3.24)	(-0.64)
N	3102	944	2158
R-sqrd	0.172	0.195	0.179

Note:

3) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
4) R-sqrd captures the goodness of fit, which measures the proportion of the total variation in dependent variable explained by the regression model.
5) Wave dummies and location dummies are included in the model. For full set of regression result, please refer to the appendix. The reference level for education level, wave and location are no education/primary education, 1991 and Beijing respectively.

Table 3.3 shows the OLS estimates for the full sample as well as the urban/rural subsamples respectively. The estimates of mother's BMI and father's BMI are significant and positive for all models, implying a positive effect of parents' weights on children's weights. Overall, the impact of mother's BMI is approximately twice as large as the impact of father's BMI (1.674 vs. 0.764), suggesting a larger effect of intergenerational BMI on the mother's side, which might be attributed to the effects of heritability. Mother-to-child BMI transmission is stronger in the rural area while father-to-child BMI transmission is stronger in the urban area.

Child's age has a significant inverted U-shaped effect on child's BMI. This might suggest an improvement in nutritional intake at the early age, and an effective control of weight increase at the later adolescence. For the overall gender effect, males have greater weight compared with females because males are generally spoiled more. For the subsample results, males living in the urban area are more likely to have higher BMI ranking, while the effect of gender is insignificant for the rural subsample. For the overall urban status effect, living in the urban area has a positive impact on children's BMI ranking. I conduct an analysis without controlling for the community variables (see result in Appendix B.1) and the coefficient for urban is 1.307. After controlling for these environmental factors, the coefficient decreases to 0.304, suggesting a positive mediating role of these environmental variables.

Parents' education level has a positive influence on child's BMI ranking. Overall, parents' education level carries important nurturing factors, with better education level leading to higher BMI ranking. And the impact is even greater in the urban area, with 13.9 percentile increase in BMI ranking for children whose parents have middle/high school education, and 17.1 percentile increase for children whose parents have college and above education. In contrast, for the rural subsamples, the effect of parental educational attainment is more mixed. The estimate of education level is insignificant for parents having middle/high school degree, whereas having a college and above degree boosts child's BMI ranking by 11.4 percentile. In the intergenerational model, the elasticity is much larger in the families with parent having no education or primary education, which implies that low SES families have strong persistence of weight problems across generations.

For the community level factors, fast food restaurants might play a large role in affecting children's BMI. Children are usually drawn to Western-style food since it offers a flavor that differs from the local Chinese cuisine. The expansion of the fast food industry in China is linked with many changing aspects, such as eating habits and culture, where China is shaped gradually as a modernized country. In my analysis sample, 15.6% of the rural sample has at least one fast food restaurant nearby while 37.7% of urban sample has at least one. For the full sample, having fast food restaurants in the community increases a child's BMI ranking by 3.6 percentiles. For the rural and urban subsample results, the evidence is quite mixed. Having fast food restaurants in the urban area is found to have insignificant impact on child's BMI, while it increases BMI ranking by 5.9 percentile for the rural children.

The child care centers play different roles on child's BMI as well. In the case of rural sample, child care for less than 3 years old increase child' BMI ranking while that for 3-6 years old decrease child's BMI ranking. The result implies that child care might lead to better nutritional inputs for infants, and more balanced diet and exercise for pre-school children. In contrast, for the urban sample, child care for 3-6 years old lead to 4.6 percentile increase in BMI ranking, while the effect of having child care for less than 3 years old is insignificant.

Notably, the constant in the urban subsample estimation is a large negative number, therefore I firstly check the possible outliers in the urban sample, especially for the child's BMI ranking. I find that although some of the BMI rankings are almost zero, their BMI, height and weight look reasonable (see Appendix B.3 for details). Therefore, they are still valid observations.

Secondly, I run OLS regression for the whole sample and urban/rural subgroups after eliminating the data with BMI percentile <=2% and >=98%. I still obtain the similar result as the untrimmed sample. I am inferring the large negative constant for the urban population is to offset the large positive estimates on the SES variable, child's age and gender. The use of the constant is to guarantee the mean of the residual to be zero. Since the coefficients for SES, child's age and gender are positive with relatively large magnitude for the urban, one comes down to a large negative value of the constant compared with the other group. I include the outliers check in Appendix B.3.

3.6.3 Estimates of Random-effects Model

As discussed in the methodology section, inheritable characteristics and some of the environmental factors are unobserved heterogeneity, which could not be measured and may result in bias in the benchmark regression estimates. In this section, I exploit the longitudinal feature of the CHNS data and use random-effects model to obtain consistent estimates which are considered to be superior to the estimates from OLS due to the elimination of unobserved heterogeneity.

The merit in the random-effects model compared to the fixed-effects model is discussed as follows. First, in a fixed-effects model, it is only possible to analyze the impact of variables that vary over time, because time-invariant variables are perfectly correlated with the fixed effect. If I used a fixed-effects model, I cannot obtain the estimates for the effects of urban status, province and gender, which are time-invariant variables. Second, the selection mechanism of individuals' urban status and province is fairly well understood so that the random-effects model should be preferred since it can produce more policy relevant estimates and allow a wider range of research issues to be addressed. Third, the estimators of regression coefficients from random-effects model are more statistically efficient. Fourth, Eriksson et al. (2014) also use random-effects model to account for the unobserved heterogeneity in health when analyzing the intergenerational inequality of health in China.

Results of full sample and urban/rural subsamples are shown in Table 3.4 below. For the overall sample, the impact of mother's BMI and father's BMI is both significant and positive on child's BMI ranking, with similar magnitude as the benchmark OLS regression result. It suggests the finding of intergenerational BMI transmission is robust to the elimination of unobserved heterogeneity. The slight decrease in the coefficient estimates of the magnitude implies that the unobserved heterogeneity is positively correlated with parents' and children's BMI level.

For the other covariates, the significance level and magnitude are largely in line with the estimates from the OLS benchmark results. Child's age has a significant inverted U-shaped effect on child's BMI. For the gender impact, the average BMI ranking increases by 2.512 for males. Compare with parents having no education or primary school education, middle/high school degree increases BMI ranking by 4.8 percentile while college and above degree increases BMI ranking by 8.7 percentile. Fast food restaurant also plays a role of increasing child's BMI ranking. Having child care for children less than 3 years old increases a child's BMI ranking while the child care for children between 3-6 years old does not have significant impact.

For the rural and urban subsamples, the results are similar as the ones estimated by OLS. For rural population, the impact of mother's BMI is approximately three times as large as the impact of father's BMI (1.646 vs. 0.645), suggesting a larger effect of intergenerational BMI on the mother's side. Mother-to-child BMI transmission is stronger in the rural area while father-to-child BMI transmission is stronger in the urban area. The gender effect is significant only for the urban population. Similar as the estimates from OLS regression, the impact of parental education is greater in the urban area, with 15.2 percentile increase in BMI ranking for children whose parents have middle/high school education, and 16.1 percentile increase for children whose parents have college and above education. In contrast, for the rural subsamples, the effect of parental educational attainment is more mixed. The estimate of education level is insignificant for parents having middle/high school degree, whereas having a college and above degree boosts child's BMI ranking by 9.9

percentile. For the community variables, the impacts have the similar magnitude and significance level as the impacts estimated from OLS regression as well.

Table 3.4: Random-effects Regression Results for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011

	Full Sample	Urban	Rural
Mother's BMI	1.583**	1.390**	1.646**
	(9.05)	(4.26)	(7.94)
Father's BMI	0.590**	1.586**	0.465**
	(5.31)	(4.83)	(3.89)
Child's Age	1.140**	2.612**	0.499
	(2.21)	(2.82)	(0.81)
Child's Age-Square	-0.102**	-0.159**	-0.0790**
	(-4.07)	(-3.59)	(-2.61)
Male	2.512**	4.430**	1.631
	(2.16)	(2.11)	(1.17)
Urban Status	0.604		
	(0.45)		
SES: Education Level			
Middle/High School	4.836**	15.24**	2.766
	(2.83)	(3.57)	(1.48)
College and Above	8.677**	16.12**	9.880**
	(3.52)	(3.35)	(2.98)
With Fast Food Restaurant	2.583*	0.705	3.960**
	(1.82)	(0.31)	(2.10)
With Child Care for <3 yrs Children	3.705**	-2.030	6.595**
	(2.79)	(-0.78)	(4.07)
With Child Care for 3-6 yrs Children	-0.951	4.095	-2.949*
	(-0.74)	(1.60)	(-1.94)
Constant	0.016	-35.05**	3.896
	0.00	(-2.85)	(0.49)
N	3102	944	2158
R-sqrd	0.168	0.191	0.170

Note:

1) t-statistic in parentheses. * and ** indicate 10% and 5% significance levels respectively.
2) BMI ranking is a continuous variable ranging from 0 to 100.

3) Location dummies are included in the regression, but not reported in this table. For full set of regression result, please refer to the appendix. The reference level for education level and location are no education/primary education and Beijing respectively.

3.6.4 Random-effects Model Compared with OLS Regression

In this section, I conduct Breusch-Pagan Lagrange Multiplier (LM) test to determine between a random-effects model and an OLS model. This test is designed to see whether there is any significant difference across units, and the null hypothesis states that variance across entities (Var (v)) is zero. The inputs for the test statistic are reported in Table 3.5. The chi-squared value is 207.43 with (Prob. > chi-squared value) = 0.00. Therefore, I could reject the null hypothesis of no variance and conclude that the random effects is appropriate. In other words, this test result shows evidence of significant differences across units and a simple OLS regression is not desirable.

Table 3.5: Inputs for Breusch and Pagan Lagrangian Multiplier Test for Random Effects

	Variance	S.d.
BMI Ranking	994.487	31.535
μ	458.139	21.404
V	366.132	19.135

3.6.5 Estimates from Fixed-effects Model and Hausman Test Results

Table 3.6 shows the fixed-effects regression results for the full sample, urban subsample and rural subsample. Following the specification in the methodology section, now the $\upsilon_{i(t)}$ is specified as υ_i, and this effect is assumed to be fixed and time-invariant. This specification removes the effect of time-invariant variables so one can assess the net effect of the covariates on the outcome variable. Since the unobserved heterogeneity is eliminated, the estimates are more accurate compared with estimates from equation (3.2). However, many of the estimates here are not statistically significant. In general, parental BMI is positively related to child's BMI ranking, although not significantly. Parental SES and child's BMI ranking are significantly positively correlated for parents having a middle/high school education level. The reason for the insignificance might be that some of the important time-invariant predictors (e.g. gender, location) are eliminated from the model. In the fixed-effects model, the change in child's BMI ranking is linked to the change in parental BMI. Changes in parental BMI probably reflect different things than the level of parental BMI. These changes do not necessarily reflect genetic factors, but rather the changes in diet.

Table 3.6: Fixed-effects Regression Results for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011

	Full Sample	Rural	Urban
Mother's BMI	0.655	0.647	0.624
	(1.06)	(0.87)	(0.56)
Father's BMI	0.078	0.104	-0.727
	(0.53)	(0.68)	(-0.84)
Child's Age	-0.242	-0.879	1.585
	(-0.26)	(-0.79)	(0.96)
Child's Age-Square	-0.030	-0.007	-0.101
	(-0.68)	(-0.13)	(-1.31)
SES: Education Level			
Middle/High School	6.989*	4.130	20.64**
	(1.85)	(0.96)	(2.51)
College and Above	2.758	0.019	16.770
	(0.46)	0.00	(1.59)
With Fast Food Restaurant	-1.004	-0.993	-0.990
	(-0.41)	(-0.31)	(-0.26)

With Child Care for <3 yrs Children	-0.539	0.619	-4.357
	(-0.24)	(0.23)	(-1.01)
With Child Care for 3-6 yrs Children	-0.173	-1.401	4.233
	(-0.07)	(-0.53)	(0.82)
Constant	28.660*	32.970*	28.690
	(1.95)	(1.87)	(0.95)
N	3102	2158	944
R-sqrd	0.033	0.037	0.016

I use Hausman test to determine whether the estimated coefficients in fixed-effects model and random-effects model are systematically different. The input results for the test statistic calculation are reported in Table 3.7. The calculated test statistic is 48.33 (Prob.>chi-squared=0.00), therefore I could reject the null hypothesis and conclude that the difference between the estimated coefficients in fixed-effects model and random-effects model is significant.

Table 3.7: Hausman Test Result (Intermediate Step) for the Difference between the Coefficients of Fixed-effects Model and Random-effects Model

	Coef. of FE	Coef. of RE	Difference	S.E.
Mother's BMI	0.655	1.583	-0.928	0.590
Father's BMI	0.078	0.590	-0.512	0.096
Child's Age	-0.242	1.140	-1.382	0.763
Child's Age-Square	-0.030	-0.102	0.072	0.036
SES: Middle/High School	6.989	4.836	2.152	3.368
SES: College and Above	2.758	8.677	-5.919	5.523
With Fast Food Restaurants	-1.004	2.583	-3.587	2.019
With Child Care for <3 Years Old	-0.539	3.705	-4.244	1.772
With Child Care for 3-6 Years Old	-0.173	-0.951	0.778	1.941

The Hausman test result implies that fixed-effects model is preferred over random-effects model. Here I provide two additional tests to further investigate the results from the fixed-effects model. The first one is to see whether the results would change after removing the parental SES variable. The second one is to check the measurement error in the fixed-effects model.

3.6.5.1 Remove the Parental SES Variable

Parental SES has probably very little variation in the fixed-effects model. For most of the cases, parental education would be unchanged, which yield volatile results. Therefore, I re-estimate the fixed-effects model without parental SES for result comparison.

Table 3.8: Fixed-effects Regression Results (Without Parental SES Variables) for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011

	Full Sample	Urban	Rural
Mother's BMI	0.688	1.008	0.630
	(1.12)	(0.91)	(0.85)
Father's BMI	0.097	-0.401	0.115
	(0.66)	(-0.47)	-0.760
Child's Age	-0.147	1.411	-0.784
	(-0.16)	(0.85)	(-0.70)
Child's Age-Square	-0.035	-0.090	-0.012
	(-0.79)	(-1.16)	(-0.22)
With Fast Food Restaurant	-1.067	-0.931	-1.069
	(-0.43)	(-0.24)	(-0.34)
With Child Care for <3 yrs Children	-0.649	-4.149	0.485
	(-0.29)	(-0.96)	(0.18)
With Child Care for 3-6 yrs Children	-0.226	4.252	-1.429
	(-0.10)	(0.82)	(-0.54)
Constant	32.75**	30.710	36.02**
	(2.29)	(1.01)	(2.10)
N	3102	944	2158

Since the result excluding parental SES variable is qualitative similar as the results without doing this treatment. I conclude that the fixed-effects model result is robust in terms of whether or not having the parental SES variable.

3.6.5.2 Check for Measurement Error in the Fixed-effects Model

If we have the measurement error in the variables, it would still most likely exist in the fixed-effects model estimation, and the attenuation bias might be stronger than OLS estimation. Especially, if the underlying variable does not change much over time, but it has measurement error in each period, the bias could be very large. Therefore, I follow Griliches and Hausman (1986) and check whether I have measurement error in the variables and the result shows that probably it exists. The detailed analysis results are provided in the appendix.

3.6.6 Discussion

The random-effects model is firstly estimated and the Breusch-Pagan Lagrange Multiplier (LM) test is employed to determine between a random-effects model and an OLS model. The Breusch-Pagan Lagrange Multiplier (LM) test result suggests that random-effects model is more desirable, compared with a simple OLS regression. Then I estimate the fixed-effects model and use Hausman test to determine how significantly parameter estimates differ between the two approaches. If the difference is not significant, then one is directed to use random effects, as they are more efficient (use fewer degrees of freedom). If the difference is significant, then one is guided to use fixed effects for non-biased estimates. The result suggests that fixed-effects model is preferred over random-effects model. However, a further investigation into the fixed-effects model result suggests that there might exist the measurement error in the variables, which would result in the attenuation bias in the model estimation, and the attenuation bias in the fixed-effects model might be stronger than in the OLS estimation.

Therefore, fixed-effects model result should be preferred, as is indicated by Hausman test result. However, one should also note that random-effects model result could be used as a reliable benchmark result, since in the presence of measurement error, the attenuation bias in the fixed-effects model is much stronger. In the future study, I would employ instrumental variable methods to address the measurement error issue in the fixed-effects model and advance this study.

3.6.7 Results from Kernel Density Estimation

Figure 3.2 and Figure 3.3 below show the stack of kernel density estimation and histogram for gender and urban status comparisons respectively. Kernel density estimation and histogram share many common characteristics in describing the probability density distribution. Kernel density estimation is similar to histogram, but is smoother compared with the discreteness of the histogram. The smoothness of kernel density estimation is due to the fact that the estimate converges faster to the true underlying density for the random variables. For the formation of the two estimation graphs, kernel density estimation is constructed as follows: one places a normal kernel on each of the data points and these kernels sums to make the kernel density estimate. While for histogram, one first divides the horizontal axis into sub-intervals and places a box of a certain height into the sub-interval if one data point falls inside the sub-interval. Ultimately, one stacks the boxes on top of each other and forms the histogram.

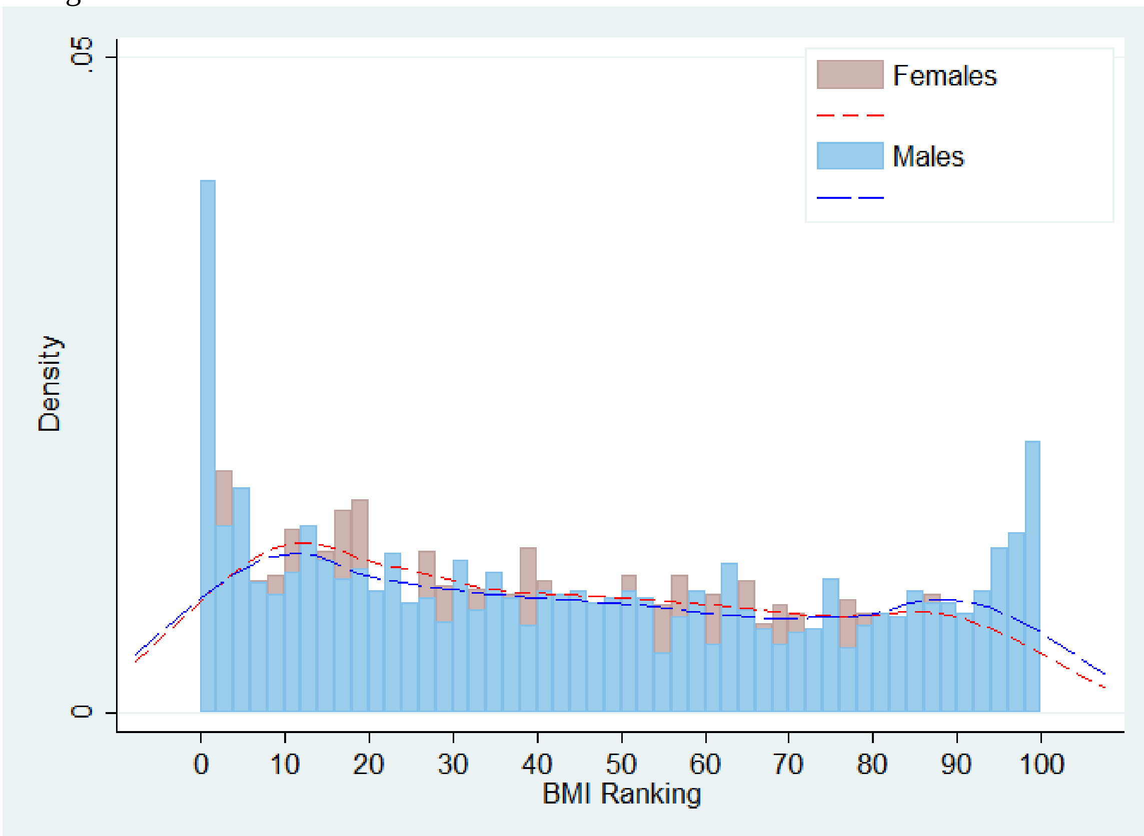

Figure 3.2: Kernel Density Estimation and Histogram for Children's Gender Group Comparison, CHNS, 2004-2011

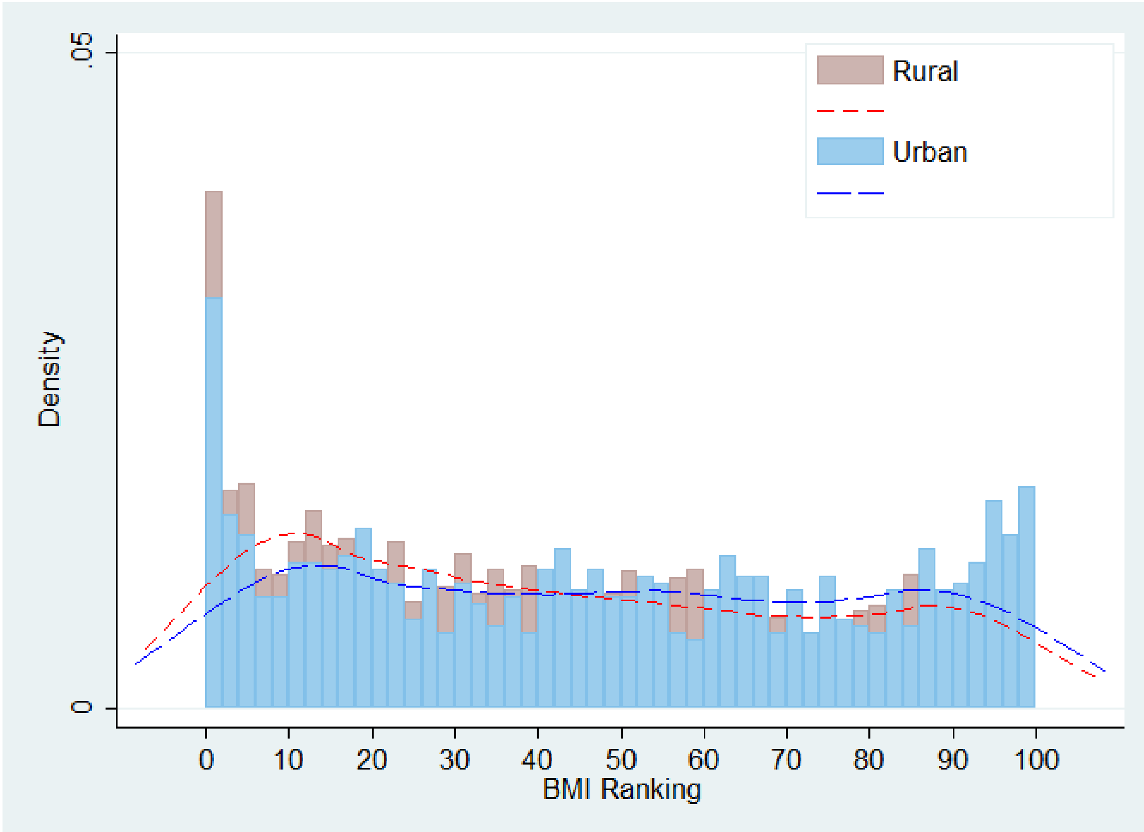

Figure 3.3: Kernel Density Estimation and Histogram for Children's Urban Status Group Comparison, CHNS, 2004-2011

The dotted line with less frequent intervals in Figure 3.2 and 3.3 represents the density of BMI for males and urban status respectively while the dotted line with more frequent intervals represents the density of BMI for females and urban status respectively. The difference between the two lines represents the effects of changes in the gender factor/urban factor on the density of BMI.

In Figure 3.2, the first thing to notice is that there is more mass around the extremely lower and upper BMI distribution for males. The mean BMI ranking for males is 45.2 while for females is 43.1. The difference between these two numbers is small and one could further define density difference as the density for males minus the density for females. The mean preserving spread of the distribution results in a positive density difference at the bottom and top of the distribution, and a negative density difference at the rest of the distribution. This implies that compared with females, males are more likely to be in the extreme weight status, either underweight or overweight, especially at the higher end.

Figure 3.3 compares the probability density for urban population and rural population. The mean BMI ranking for rural children is 42.8 while for urban children is 47.7. More mass is accumulated in the lower BMI distribution for rural children while in the upper BMI distribution for urban children. Comparing Figures 3.2 and 3.3, I find that urban/rural disparity in BMI ranking is more pronounced than males/females disparity, which motivates me to perform Blinder-Oaxaca decomposition analysis in the following section to quantify the urban-rural differential in child's BMI, and to understand to what extent the difference can be explained.

3.6.8 Results from Blinder-Oaxaca Decomposition

The kernel density estimation results suggest that urban children generally have higher BMI levels compared with their rural counterparts. For the known attributes, the OLS regression analysis demonstrates that different factors play different roles in determining child's BMI levels for rural and urban subsamples. For example, for the urban population, the influence of father's BMI is much greater than mother's BMI (1.718 vs. 1.405). In contrast, mother's BMI level plays a larger role for the rural population. A one unit increase in mother's BMI (father's BMI) increases child's BMI ranking by 1.777 (0.591). Child's gender is significant for the urban population, but insignificant for the rural children, probably because the “little emperor” effect is more pronounced in the urban areas. Parents’ education level plays larger role, while having fast food restaurant seems unimportant in determining child’s BMI for the urban children.

Although some of the urban-rural differential in BMI can be explained by the above mentioned predictors, there are some factors which are inherent with urban/rural status and are likely to be discriminatory factors. Below I show some background information about the disparity of rural and urban China in terms of healthcare. This might serve as an example of the factor that differs between urban and rural areas, and might contribute to the BMI ranking differential. But it could not be included in the analysis due to data constraint. Tracing back to the early 1980s, China had its rural cooperative medical system (CMS). However, it collapsed due to the economic reforms in the post 1980s period. China then started its health system reform with the aim of reducing the urban-rural gap in health care access. The New Rural Cooperative Medical Care System (NRCMCS) is a new initiative conducted in 2003, with the goal of providing affordable health care for the poor people in the rural areas. In spite of this effort, the disparity in health inequality still persists between rural and urban areas, since the government’s focus is more on the urban area and it is not easy to provide universal healthcare to the rural areas.

Table 3.9 presents the Blinder-Oaxaca decomposition results for urban and rural children using the estimates from random-effects models. Although fixed-effects model result should be preferred, as is indicated by Hausman test result, I choose to use the estimates from the random-effects model here, since in the presence of measurement error, the attenuation bias in the fixed-effects model is much stronger.

Moreover, the estimates from random-effects model provide additional estimates for the time-invariant variables. Notably, there is a slight difference for the means of urban and rural BMI ranking when estimated by random-effects model. This is probably because a very few observations are not entering into random-effects model estimation. The urban/rural differential is 4.84 in OLS estimation while 4.53 in random-effects estimation. In my analysis result, the mean BMI percentile ranking is 47.81 for urban group and 43.27 for rural group, yielding a gap of 4.53. This gap is further divided into two components: explained and unexplained. The "explained" component represents the effect of the observed difference in characteristics such as parents' BMI levels, SES, environment and access to child care, if those factors affected rural children in the same way they affected urban children. 3.28 of the total 4.53 BMI percentile gap is "explained", which suggests that urban-rural differences in mother's BMI, father's BMI, SES (e.g. parents' education level) and community environment account for more than half of the urban-rural BMI ranking gap. The second component "unexplained" shows the unobserved difference in the impact of the other factors on children's BMI ranking. More specifically, it quantifies the change in rural children's BMI when applying the urban children's coefficients to the rural children's characteristics. This "unexplained" component is 1.25 in BMI ranking (27.7%). Together the "explained" and "unexplained" components explain the entire BMI ranking gap.

Table 3.9 also contains the detailed composition of the observed BMI disparity. The variables are grouped into several categories: Parents' weight (mother's BMI and father's BMI); SES (parents' education level); environmental factors (having fast food restaurant or not, having child care for children less than 3 years old, and having child care for children between 3-6 years old) and all other variables (child's age and gender). Differences in mother's BMI and father's BMI explain 7.3% and 3.8% of the BMI ranking gap. This makes sense since parents' weight has a positive impact on children's weight and urban parents usually have larger BMI levels. Differences in SES for urban and rural groups account for 45.6% of the gap, which implies the dominant role of SES in determining urban/rural disparity. The magnitude of the difference is 2.1, which indicates that if the rural parents had same education level as the urban ones, the difference in their children's BMI ranking could be reduced by 2.1 percentiles. For the environmental factor, the presence of fast food restaurants explains 21.1% of the gap. Differences in percentages of having private child care for <3 years old children and 3-6 years old children explain 8.6% and 2.8% of the BMI ranking gap respectively. The positive sign means that the difference in percentages of having private child care would cause urban children to have larger BMI than rural children.

Table 3.9: Blinder-Oaxaca Decomposition for Urban/Rural Groups Using Random-effects Model Results, CHNS, 2004-2011

	Explained		Unexplained	
Variable	Magnitude	Portion	Magnitude	Portion
Parents' Weight				
Mother's BMI	0.331	7.30%	-10.549	-232.63%
Father's BMI	0.171	3.77%	31.126	686.42%
SES				
Parents' Education	2.068	45.61%	2.028	44.73%

Environmental Factors				
With Fast Food Restaurant	0.958	21.13%	-0.332	-7.32%
With Private Child Care for <3 yr Children	0.391	8.62%	-3.297	-72.70%
With Private Child Care for 3-6 yr Children	0.126	2.79%	4.124	90.96%
All Other Variables	-0.766	-16.89%	-21.846	-481.78%
Total	3.280	72.33%	1.255	27.67%

For the “unexplained” column, differences in mother’s BMI and father’s BMI account for -10.5 and 31.1 of the BMI ranking gap in magnitude respectively. The differences in the signs are explained by the fact that mother’s BMI and father’s BMI have different impacts on children’s BMI in terms of the magnitude for the rural and urban populations. More specifically, the coefficients of mother’s BMI for the urban and rural populations are 1.390 and 1.646 respectively, while the coefficients of father’s BMI are 1.586 and 0.465 respectively from the random-effects model estimations. Therefore, mother-to-child BMI transmission is stronger in the rural area while father-to-child BMI transmission is stronger in the urban area. Therefore, applying the coefficient from the urban population on the rural population for mother’s BMI would yield a negative value.

In all, the Blinder-Oaxaca decomposition results suggest that more than half of the BMI ranking disparity between urban and rural children is attributable to the differences in the endowments of urban and rural children. Of this total, parents’ education level plays a dominant role in contributing to children’s BMI differential.

3.7 Concluding Remarks

As is widely known, China's rapid economic growth in recent decades is accompanied by a weight increase in children, which might be caused by profound changes in society and in behavioral patterns due to nutrition transition and globalization. In spite of the nurturing effect, it is also interesting to investigate whether weight is transferred across generations, and to explore the roles of other factors in the weight transfer. The results of intergenerational transfer might help us understand whether the increase in child's weight is partially due to the increase in adult's weight.

Using data from China Health and Nutrition Survey, this study provides several empirical results of the intergenerational persistence of weight. The estimates show that for the full sample, the intergenerational elasticity of BMI between mothers and children is 2.05. The estimates by gender suggest larger intergenerational correlations among mothers and their daughters, which is consistent with findings from Classen (2010). Results by education level indicate a greater persistence of weight at lower education level. This implies that low SES families may have strong persistence of weight problems between generations.

Parental BMI is an important predictor for children's BMI after controlling for the demographic variable (child's age and gender); socio-economic status (parental education level); living environment (having fast food restaurant or not), and access to child care (having child care for children less than 3 years old, and having child care for children between 3-6 years old) from the results of the OLS regression. Comparing the results of rural and urban subsamples, mother-to-child BMI transmission is stronger in the rural area while father-to-child BMI transmission is stronger in the urban area.

For the results from the longitudinal analysis, I have debates and trade-off here since no model is superior in every aspect. Although fixed-effects model result should be preferred as indicated by Hausman test result, random-effects model should also have merits since in the presence of measurement error, the attenuation bias in the random-effects model would be much less. After eliminating the unobserved heterogeneity using the random-effects model, I find that the impact of mother's BMI and father's BMI is both significant and positive on child's BMI ranking, with similar magnitude as the benchmark OLS regression result. The slight decrease in the coefficient estimates of the magnitude implies that the unobserved heterogeneity is positively correlated with parents' and children's BMI level. The fixed-effects model suggests that parental BMI is positively related to child's BMI ranking, although little evidence implies the result is significant. For SES, parents having a middle/high school education level would have children with significantly higher BMI ranking.

The kernel density estimation and histograms suggest that urban/rural disparity in BMI ranking is more pronounced than the males/females disparity. A Blinder-Oaxaca decomposition analysis using the estimates of random-effects model suggests that more than half of the BMI ranking disparity in children are attributable to the endowment of urban and rural sectors. Of this total, parents' education level plays a dominant role in contributing to children's BMI differential. For example, if the rural parents had a same education level as the urban ones, the difference in their children's BMI ranking could be reduced by 2.1 percentile.

To my best knowledge, this study contributes the first evidence on the intergenerational persistence of weight. The most consistent result emerging from this research is the contribution of parents' BMI in determining children's BMI. Given the strength of the correlation between parents and children's weight, particular policies should focus on the entire families. There are statistically significant gender differences in children's BMI ranking, where males are more likely to have higher weight. While the result suggests the role of genetics and maybe sharing environment is important, other factors might be also crucial, such as parents' education level. Moreover, since the intergenerational transmission of weight is found to be more pronounced in the low SES families, policies could be implemented to target this issue.

Notably, the above results should be interpreted in light of caveats. Although all the other results find that parents' BMI have significant impact on child's weight, fixed-effects model suggests little evidence of such effect. However, fixed-effects model might suffer from very strong attenuation bias in the presence of measurement error in this study, therefore, it is not the champion approach. Future investigations should pursue instrumental variable approach to solve the measurement error problem. Moreover, the economic consequence of the intergenerational BMI transmission could be another line of study to explore for future study.

Chapter 4

CONCLUSION

As is widely known, China's rapid economic growth in recent decades is accompanied by a weight increase in children, which might be caused by profound changes in society and in behavioral patterns due to nutrition transition and globalization. This dissertation contributes to the literature by examining Chinese children's weight changes from two perspectives. The first one addresses children's weight changes from the impact of parental SES. The results show that child's weight is positively correlated to SES and the weight disparities due to SES generally decrease with age. The results from the stratified analysis suggest primarily two things for the impact of high SES on obesity prevalence: 1) high SES plays more role for urbanized people; 2) high SES has more impact in 2000s'. It is tempting to infer that the rise of childhood obesity, especially in the urban area and among high SES families in China might be attributed to the globalization beginning in the 2000s which modifies the culture of calorie intake and energy expenditure.

The results from the first study indicate the need of considering gender-specific, age-specific and urban/rural-specific approaches in developing intervention strategies of child weight increase in China. In general, I suggest offering more health education to children as well as their parents about the risk of obesity. While it is difficult to reject globalization, the society as a whole needs to transform their traditional view of childhood obesity, beware of children's obesity-related eating behaviors and urge the children to increase more physical activities.

In spite of the nurturing effect, it is also interesting to investigate whether weight is transferred across generations, and to explore the roles of other factors in the weight transfer. My second study contributes the first evidence on the intergenerational persistence of weight. The most consistent result emerging from this research is the contribution of parents' BMI in determining children's BMI. Given the strength of the correlation between parents and children's weight, particular policies should focus on the entire families. There are statistically significant gender differences in children's BMI ranking, where males are more likely to have higher weight. While the result suggests the role of genetics and maybe sharing environment is important, other factors might be also crucial, such as parents' education level. Moreover, since the intergenerational transmission of weight is found to be more pronounced in the low SES families, policies could be implemented to target this issue.

Notably, the above results should be interpreted in light of caveats. Although all the other results find that parents' BMI have significant impact on child's weight, fixed-effects model suggests little evidence of such effect. However, fixed-effects model might suffer from very strong attenuation bias in the presence of measurement error in this study, therefore, it is not the champion approach. Future investigations should pursue instrumental variable approach to solve the measurement error problem. Moreover, the economic consequence of the intergenerational BMI transmission could be an interesting topic to explore in the future.

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Appendix A

ADDITIONAL ANALYSES RELATED TO CHAPTER TWO

A.1 : Explaining the Peak in Obesity Rate around 4 Years Old

Figure 3.3 in the main analysis shows that the overweight and obesity prevalence for Chinese children grows rapidly with age before 4 years old, but declines gradually till 18 years old. This section provides analysis explaining the trend in BMI of CHNS data, especially the peak in obesity rate around 4 years old.

As the first step, I show the average and median weight, height and BMI for children at different ages in Table A1 and Figure A1. They both show no obvious irregularities of weight, height or BMI at age 4 for Chinese children. And it is observed that there is a drop in the BMI around year 5. Then why do we observe a peak in obesity rate around year 4 in Figure 3.3?

Table A1: Child's Weight and Height at Different Age, CHNS, 1991-2011

Age	Average Height	Median Height	Average Weight	Median Weight	Average BMI
2	87.25994	87	12.70462	12.5	16.69134
3	95.2693	95	14.67209	14.5	16.13314
4	101.6031	101	16.42201	16	15.87357
5	108.1558	108	18.04916	17.5	15.39751
6	113.8587	113.6	20.10272	19.5	15.46215
7	119.4412	119.5	22.12185	21.2	15.45054
8	124.6448	124.5	24.57821	23.65	15.72311

9	130.505	130	27.5346	26.05	16.05794
10	135.2181	135	30.21518	29	16.42057
11	141.229	140.8	34.15257	32.45	16.94428
12	146.9069	147	37.82181	36.95	17.37891
13	152.2365	152.2	42.32941	41	18.11149
14	156.8508	157	46.31345	45	18.70393
15	159.3426	159.2	49.30429	48.3	19.33313
16	161.6209	161.15	51.87495	51	19.8063
17	163.2228	163.3	53.70213	52.8	20.10853
18	163.7526	163.5	54.86743	54	20.41228

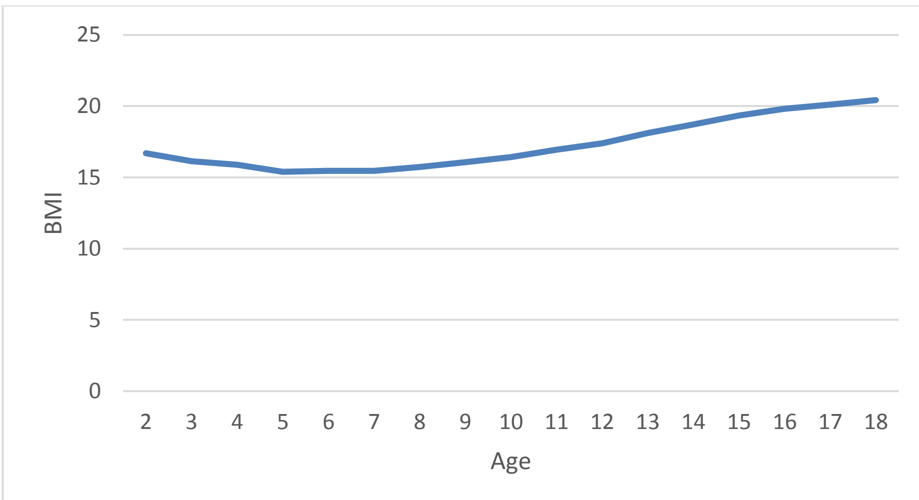

Figure A1: Child's Average BMI by Age, CHNS, 1991-2011

The peak of obesity rate at age 4 might be largely attributed to the CDC chart, where the lowest point is at 5 years old for the 95 percentile [10] which is based on the U.S. population. The same BMI number, say 18, is classified as obese at age 4, but only overweight at age 3 or age 5. Then the next question is whether we could use the overweight and obesity classifications from U.S. populations on Chinese dataset.

10 Source: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html

The answer is yes. From a heavily cited paper[11], the authors demonstrate that the weight patterns of Hong Kong and U.S. children are very similar. Hong Kong can be a fair representation of China. Therefore the BMI cut-off by CDC may be reasonable to be used on Chinese children. However, it is still tempting to say that the cut-off is subjective. I use quantile regression to address this issue in this dissertation, which provides the full picture of the SES's impact on the whole BMI distribution.

A.2 : Test for Possible Sample Attrition

To create my dataset, I identify and match the child-parent information and delete those with missing values on the key variables (in this case, child's BMI information and SES information). This gives me 19,160 observations. Some of these have missing value on father's age, some have missing values on mother's BMI information, or other independent variables, etc. Therefore in the regression, I only have 12,311 observations with full information. In order to rule out the possibility that there is an attrition effect, the comparison of obesity and overweight status between these two samples is provided below.

11 Figure of Centiles for obesity by sex for each dataset, passing through body mass index of 30 kg/m2 at age 18 Reference: Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. Bmj, 320(7244), 1240.

In this section, I compare the sample used for regression (N: 12,311) and the sample not used for regression (N: 6,849) due to missing values on some of the non-key variables (e.g. father's BMI, mother's BMI and urban status).

Table A2: Mean Difference between Sample in Use and Sample Not in Use

	obesity %	overweight status%	N
Sample in Use	4.1%	9.8%	12311
Sample not in Use	4.2%	10.7%	6849
Difference	0.0%	1.0%	

To be more formal, I performed a t-test to examine the whether the difference is 5% statistically significant.

Table A3: T-test Comparing Group Means for Obesity and Overweight Status

Obese%	Method	Variances	t Value	Pr > |t|
	Pooled	Equal	0.38	0.71
	Satterthwaite	Unequal	0.37	0.71
Overweight%	Method	Variances	t Value	Pr > |t|
	Pooled	Equal	1.91	0.06
	Satterthwaite	Unequal	1.89	0.06

I cannot reject the null hypothesis at 5% level. Therefore, I conclude that there is the two samples are not statistically different in terms of child's weight. I can, therefore, proceed with the analysis without worrying about the attrition effect.

A.3 : Sensitivity Analysis Using Different SES Cut-offs

In my analysis, I have three SES groups with cut-offs determined by conventional school grade level (e.g. no education/primary school; middle/high school; college). For example, "Low" SES group is defined as completing <= 6 years of formal education in a regular school. "Medium" SES group is defined as completing 6-12 years of formal education in a regular school and the rest are classified into "high" SES group. In my analysis sample, 28.41%, 66.39% and 5.2% of the children fall into "low", "medium" and "high" SES groups. Considering the high SES group contains relatively small number, I conduct a study of descriptive analysis using a different SES cut-off. In the tested SES cut-off scenario, the numbers of data points in each group are more similar.

1. Set-up

1) Original SES cut-off: 1. no edu/primary school; 2. middle/high school; 3. college and beyond:

# of observations for these three groups: 5443, 12721, 996

Avg. household income per year (in renminbi): 8872, 16418, 50554

2) Tested SES cut-off: 1. no edu/primary school; 2. middle school; 3. high school and beyond:

# of observations for these three groups: 5443, 8008, 5709

Avg. household income per year (in renminbi): 8872, 14549, 24994.

It is easy to see that the income difference between different SES groups is not strong under the tested SES cut-off, therefore the original SES cut-off is preferred.

2. Descriptive Result

Below is the age-specific obesity prevalence by SES using the revised SES cut-off. We can see that the separation of obesity level is much smaller using this SES cut-off.

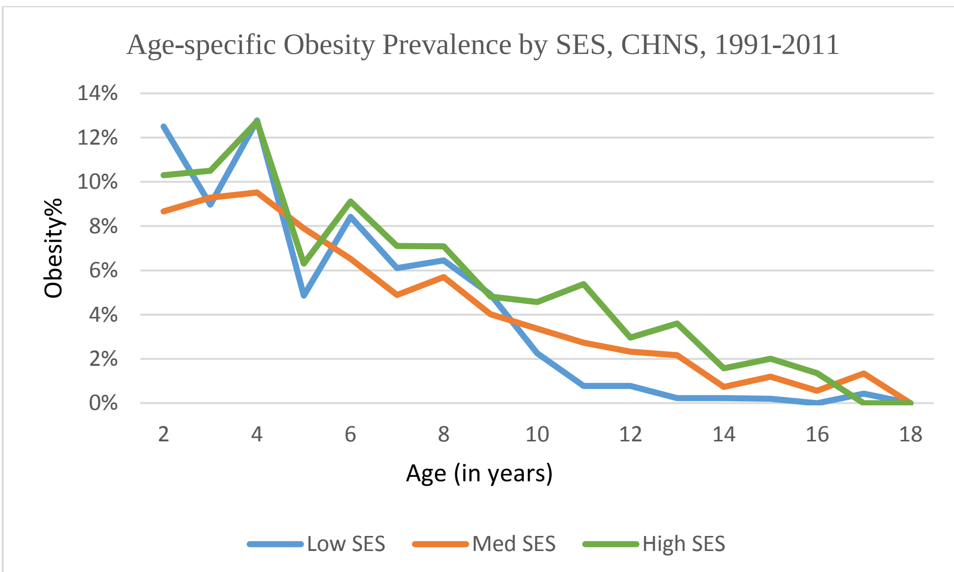

Figure A2: Age-specific Obesity Prevalence by SES, CHNS, 1991-2011

Moreover, for the original SES cut-off, high SES group has 10.1% and 8.6% overweight and obese children respectively. In contrast, for the revised SES cut-off, high SES group has 8.0% and 5.4% overweight and obese children respectively.

3. Rationale and Summary

Because the high school education is now classified into high SES under the tested SES cut-off, the "new" high SES group does not solely represent the high-end families which could get access to the globalized lifestyles (fast food chains, easy transportation). Instead, the new" high SES group is now a mix of high school and college education levels, and hence not homogeneous. In contrast, different SES groups are more similar in terms of household income, which is not desirable. In this way, the separation between SES groups is not strong in terms of household income and obesity level. Under the original SES cutoff, avg. household income for different SES group varies significantly. However under the tested SES cutoff, average household income for different SES group is close, which is not desirable.

Therefore, I conclude that I should utilize the original SES cut-off and acknowledge that the number of observations in the high SES is comparatively small.

A.4 : Full Set of Regression Results

Table A4: Full Set of OLS Estimates of Effect of SES (Education Level) on Children's BMI, Overweight Status and Obesity, China, 1991-2011 (Table 2.3)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-1.881**	-1.705**	-0.0127**	-0.0142**	-0.0119**	-0.0120**
	(-7.45)	(-5.83)	(-4.78)	(-4.61)	(-6.60)	(-5.77)
Child's Age-Square	0.0468**	0.0438**	5.04E-05	7.64E-05	0.000226**	0.000230**
	(3.85)	(3.53)	(0.39)	(0.58)	(2.62)	(2.62)
SES: Education Level						
Middle/High School	-0.426	1.318	-0.00612	-0.0224	-0.00965**	-0.0136
	(-0.70)	(0.83)	(-0.96)	(-1.34)	(-2.24)	(-1.20)
College and Above	4.557**	6.456**	0.0388**	0.0502*	0.0151*	0.0565**
	(3.70)	(2.25)	(2.99)	(1.66)	(1.73)	(2.77)
Child's Age * SES						
*Age*Middle/High School*		-0.155		0.00149		0.000419
		(-1.18)		(1.07)		(0.45)
*Age*College and Above*		-0.169		-0.00121		-0.00401**
		(-0.69)		(-0.47)		(-2.30)
Male	0.70	0.71	0.0227**	0.0227**	0.0180**	0.0181**
	(1.43)	(1.45)	(4.41)	(4.40)	(5.19)	(5.20)
Urban Status	2.044**	2.041**	0.0217**	0.0218**	0.00	0.00
	(3.58)	(3.58)	(3.61)	(3.62)	(0.72)	(0.75)
Father's BMI	1.226**	1.227**	0.00700**	0.00700**	0.00326**	0.00328**
	(15.26)	(15.27)	(8.26)	(8.26)	(5.72)	(5.74)
Mother's BMI	1.555**	1.558**	0.00876**	0.00874**	0.00286**	0.00288**
	(18.08)	(18.10)	(9.66)	(9.64)	(4.68)	(4.71)
Wave						
1993	1.522**	1.512**	0.0148*	0.0148*	0.00696	0.00687
	(2.06)	(2.05)	(1.90)	(1.90)	(1.33)	(1.31)
1997	0.815	0.843	0.0132	0.0126	0.00857	0.00797
	(1.01)	(1.05)	(1.55)	(1.48)	(1.50)	(1.39)
2000	0.136	0.181	0.0152*	0.0143	0.00753	0.00677
	-0.16	-0.21	(1.65)	(1.56)	(1.22)	(1.09)
2004	2.602**	2.676**	0.0395**	0.0384**	0.0109	0.01
	(2.47)	(2.53)	(3.55)	(3.44)	(1.45)	(1.33)
2006	0.401	0.461	0.0318**	0.0309**	0.0195**	0.0188**

	-0.34	-0.39	(2.59)	(2.51)	(2.35)	(2.27)
2009	-0.78	-0.743	0.0436**	0.0429**	0.0171**	0.0165*
	(-0.65)	(-0.62)	(3.44)	(3.38)	(2.01)	(1.94)
2011	2.299*	2.316*	0.0812**	0.0807**	0.0715**	0.0710**
	(1.83)	(1.84)	(6.12)	(6.09)	(8.00)	(7.94)
Province						
Liaoning	-10.31**	-10.26**	-0.0383	-0.0364	0.011	0.0145
	(-3.69)	(-3.66)	(-1.30)	(-1.23)	(0.55)	(0.73)
Heilongjiang	-7.592**	-7.558**	-0.0444	-0.0422	-0.00521	-0.00123
	(-2.70)	(-2.68)	(-1.50)	(-1.42)	(-0.26)	(-0.06)
Shanghai	-0.285	-0.253	0.0298	0.0296	0.0483**	0.0484**
	(-0.08)	(-0.07)	(0.83)	(0.83)	(2.01)	(2.01)
Jiangsu	-7.035**	-7.024**	-0.0391	-0.0373	-0.00947	-0.00648
	(-2.53)	(-2.52)	(-1.33)	(-1.27)	(-0.48)	(-0.33)
Shandong	0.642	0.66	0.0549*	0.0568*	0.0446**	0.0477**
	(0.23)	(0.24)	(1.86)	(1.92)	(2.24)	(2.40)
Henan	-9.715**	-9.701**	-0.0609**	-0.0586**	-0.0149	-0.011
	(-3.49)	(-3.47)	(-2.07)	(-1.99)	(-0.75)	(-0.56)
Hubei	-16.79**	-16.78**	-0.0814**	-0.0792**	-0.0188	-0.0152
	(-6.04)	(-6.03)	(-2.78)	(-2.70)	(-0.95)	(-0.77)
Hunan	-9.832**	-9.822**	-0.0419	-0.0399	0.00835	0.0116
	(-3.53)	(-3.52)	(-1.43)	(-1.36)	(0.42)	(0.59)
Guangxi	-18.96**	-18.92**	-0.0944**	-0.0925**	-0.0293	-0.0258
	(-6.89)	(-6.86)	(-3.25)	(-3.18)	(-1.50)	(-1.32)
Guizhou	-14.12**	-14.11**	-0.0849**	-0.0827**	-0.0207	-0.0171
	(-5.12)	(-5.11)	(-2.92)	(-2.84)	(-1.06)	(-0.87)
Chongqing	-9.522**	-9.444**	-0.0311	-0.0301	0.0227	0.0253
	(-2.47)	(-2.45)	(-0.77)	(-0.74)	(0.83)	(0.92)
Constant	1.057	-0.699	-0.113**	-0.102**	-0.0134	-0.0166
	(0.28)	(-0.17)	(-2.82)	(-2.36)	(-0.49)	(-0.57)
N	12311	12311	12311	12311	12311	12311

Table A5: Full Set of OLS Estimates of Effects of SES (Household Income) on Children's BMI, Overweight Status and Obesity, CHNS, 1991-2011 (Table 2.4)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-1.859**	-1.978**	-0.0125**	-0.0128**	-0.0117**	-0.0109**
	(-7.35)	(-7.72)	(-4.67)	(-4.72)	(-6.53)	(-5.98)
Child's Age-Square	0.0462**	0.0477**	4.42E-05	4.79E-05	0.000230**	0.000220**
	(3.80)	(3.92)	(0.34)	(0.37)	(2.66)	(2.54)
HH Income	0.0248**	(0.02)	0.000337**	0.00	0.00	0.000416**
	(2.01)	(-1.16)	(2.59)	(0.93)	(0.66)	(2.73)
Child's Age * HH Income		0.00544**		0.00		-0.0000392**
		(2.83)		(0.69)		(-2.87)
Male	0.66	0.65	0.0225**	0.0224**	0.0179**	0.0179**
	(1.35)	(1.34)	(4.36)	(4.36)	(5.15)	(5.17)
Urban Status	2.400**	2.330**	0.0240**	0.0238**	0.00	0.00
	(4.31)	(4.18)	(4.08)	(4.05)	(1.03)	(1.16)
Father's BMI	1.242**	1.241**	0.00709**	0.00709**	0.00331**	0.00331**
	(15.50)	(15.50)	(8.40)	(8.40)	(5.81)	(5.82)
Mother's BMI	1.525**	1.528**	0.00852**	0.00853**	0.00272**	0.00270**
	(17.80)	(17.83)	(9.44)	(9.44)	(4.47)	(4.44)
Wave						
1993	1.498**	1.505**	0.0142*	0.0143*	0.00651	0.00646
	(2.03)	(2.04)	(1.83)	(1.84)	(1.24)	(1.23)
1997	0.612	0.628	0.0101	0.0102	0.00692	0.00681
	(0.76)	(0.78)	(1.19)	(1.20)	(1.21)	(1.19)
2000	-0.044	-0.036	0.0119	0.0119	0.00559	0.00553
	(-0.05)	(-0.04)	(1.30)	(1.30)	(0.91)	(0.90)
2004	2.310**	2.275**	0.0345**	0.0344**	0.00842	0.00867
	(2.18)	(2.15)	(3.09)	(3.08)	(1.12)	(1.15)
2006	0.14	0.0697	0.0266**	0.0264**	0.0176**	0.0181**
	-0.12	-0.06	(2.14)	(2.12)	(2.10)	(2.16)
2009	-1.441	-1.614	0.0329**	0.0324**	0.0146	0.0158*
	(-1.13)	(-1.26)	(2.44)	(2.41)	(1.61)	(1.74)
2011	1.312	1.178	0.0658**	0.0655**	0.0681**	0.0690**
	(0.94)	(0.84)	(4.46)	(4.44)	(6.84)	(6.94)
Province						
Liaoning	-11.89**	-12.00**	-0.0497*	-0.0500*	0.00102	0.00181
	(-4.29)	(-4.33)	(-1.70)	(-1.71)	(0.05)	(0.09)
Heilongjiang	-9.136**	-9.281**	-0.0550*	-0.0554*	-0.0141	-0.013
	(-3.28)	(-3.33)	(-1.87)	(-1.89)	(-0.71)	(-0.66)
Shanghai	-2.152	-1.952	0.00968	0.0102	0.0405*	0.04
	(-0.63)	(-0.58)	(0.27)	(0.28)	(1.68)	(1.62)
Jiangsu	-8.872**	-8.970**	-0.0533*	-0.0536*	-0.0196	-0.0189
	(-3.23)	(-3.27)	(-1.84)	(-1.85)	(-1.01)	(-0.97)

Shandong	-1.147	-1.247	0.04	0.04	0.0339*	0.0347*
	(-0.42)	(-0.45)	(1.43)	(1.42)	(1.73)	(1.77)
Henan	-11.34**	-11.47**	-0.0722**	-0.0725**	-0.0246	-0.0237
	(-4.10)	(-4.15)	(-2.48)	(-2.49)	(-1.26)	(-1.21)
Hubei	-18.64**	-18.73**	-0.0951**	-0.0954**	-0.0298	-0.0292
	(-6.80)	(-6.83)	(-3.29)	(-3.30)	(-1.53)	(-1.50)
Hunan	-11.69**	-11.74**	-0.0560*	-0.0561*	-0.00228	-0.0019
	(-4.25)	(-4.27)	(-1.93)	(-1.94)	(-0.12)	(-0.10)
Guangxi	-20.87**	-20.94**	-0.108**	-0.109**	-0.0405**	-0.0399**
	(-7.69)	(-7.72)	(-3.79)	(-3.80)	(-2.10)	(-2.07)
Guizhou	-15.85**	-15.93**	-0.0969**	-0.0970**	-0.0296	-0.029
	(-5.83)	(-5.86)	(-3.38)	(-3.38)	(-1.53)	(-1.50)
Chongqing	-10.83**	-11.05**	-0.038	-0.0385	0.0153	0.0169
	(-2.82)	(-2.87)	(-0.94)	(-0.95)	(0.56)	(0.62)
Constant	2.654	3.704	-0.104**	-0.101**	-0.00846	-0.016
	-0.7	-0.98	(-2.61)	(-2.53)	(-0.32)	(-0.59)
N	12311	12311	12311	12311	12311	12311

Table A6: Full Set of OLS Estimates of Effects of SES (Education Level) in Children's BMI, Overweight Status and Obesity Controlling for Smoking and Drinking, CHNS, 1991-2011 (Table 2.5)

	(1)	(2)	(3)
	BMI	Overweight	Obesity
Child's Age	-1.701**	-0.0139**	-0.0120**
	(-5.77)	(-4.48)	(-5.69)
Child's Age-Square	0.0452**	0.0000779	0.000235**
	(3.61)	(0.59)	(2.63)
SES: Education Level	1.777	-0.0192	-0.0122
Middle/High School	(1.10)	(-1.13)	(-1.06)
	6.966**	0.0549*	0.0599**
College and Above	(2.40)	(1.80)	(2.90)
Child's Age * SES			
*Age*Middle/High School*	-0.198	0.00113	0.000297
	(-1.49)	(0.81)	(0.31)
*Age*College and Above*	-0.205	-0.00175	-0.00427**
	(-0.83)	(-0.67)	(-2.43)
Male	0.814*	0.0229**	0.0179**
	(1.65)	(4.41)	(5.07)
Urban Status	1.972**	0.0241**	0.00436
	(3.39)	(3.93)	(1.05)
Father's BMI	1.238**	0.00697**	0.00329**
	(15.28)	(8.16)	(5.71)
Mother's BMI	1.571**	0.00898**	0.00296**
	(18.03)	(9.78)	(4.76)
Father's Smoking	0.609	-0.00657	-0.0000824
	(1.10)	(-1.12)	(-0.02)
Mother's Smoking	-0.543	-0.0119	-0.0119
	(-0.31)	(-0.64)	(-0.95)
Father's Drinking	-0.858	0.00236	0.000538
	(-1.53)	(0.40)	(0.13)
Mother's Drinking	1.053	-0.00281	-0.00821
	(1.34)	(-0.34)	(-1.47)
Wave			
1993	1.498**	0.0135*	0.00673
	(2.01)	(1.72)	(1.27)

1997	0.856	0.0113	0.00674
	(1.05)	(1.31)	(1.16)
2000	0.27	0.0149	0.00702
	(0.30)	(1.59)	(1.11)
2004	2.708**	0.0370**	0.00896
	(2.54)	(3.30)	(1.18)
2006	0.481	0.0292**	0.0177**
	(0.41)	(2.36)	(2.12)
2009	-0.736	0.0414**	0.0156*
	(-0.61)	(3.26)	(1.81)
2011	2.331*	0.0789**	0.0699**
	(1.85)	(5.92)	(7.77)
Province			
Liaoning	-10.13**	-0.0352	0.0144
	(-3.61)	(-1.19)	(0.72)
Heilongjiang	-7.285**	-0.0375	0.001
	(-2.57)	(-1.26)	(0.05)
Shanghai	-0.265	0.0304	0.0478**
	(-0.08)	(0.85)	(1.98)
Jiangsu	-6.908**	-0.0364	-0.00661
	(-2.47)	(-1.24)	(-0.33)
Shandong	0.701	0.0565*	0.0456**
	(0.25)	(1.91)	(2.28)
Henan	-9.667**	-0.0584**	(0.01)
	(-3.45)	(-1.98)	(-0.57)
Hubei	-16.70**	-0.0794**	-0.0151
	(-5.99)	(-2.70)	(-0.76)
Hunan	-9.853**	-0.0399	0.0113
	(-3.52)	(-1.35)	(0.57)
Guangxi	-18.77**	-0.0922**	-0.0265
	(-6.79)	(-3.16)	(-1.34)
Guizhou	-14.13**	-0.0814**	-0.017
	(-5.10)	(-2.79)	(-0.86)
Chongqing	-9.500**	-0.0286	0.026
	(-2.46)	(-0.70)	-0.94
Constant	-1.582	-0.106**	-0.018
	(-0.38)	(-2.41)	(-0.61)
N	12098	12098	12098

Table A7: Full Set of Logistic Regression Results Using Education and Household Income as SES Respectively, CHNS, 1991-2011 (Table 2.6)

	(1)	(2)	(3)	(4)
	Overweight	Overweight	Obesity	Obesity
Child's Age	-0.0361	-0.0351	-0.005	-0.00479
	(-1.08)	(-1.05)	(-0.09)	(-0.09)
Child's Age-Square	-0.00612**	-0.00618**	-0.0122**	-0.0122**
	(-3.45)	(-3.48)	(-3.87)	(-3.85)
SES: Education Level				
Middle/High School	0.0147		-0.151	
	(0.16)		(-1.12)	
College and Above	0.353**		0.21	
	(2.45)		(0.99)	
SES: Household Income (in 000')		0.00145		-0.000547
		(1.18)		(-0.34)
Male	0.291**	0.285**	0.517**	0.512**
	(4.45)	(4.36)	(5.17)	(5.13)
Urban Status	0.319**	0.357**	0.18	0.220**
	(4.41)	(5.09)	(1.61)	(2.08)
Father's BMI	0.0822**	0.0838**	0.0569**	0.0587**
	(7.43)	(7.62)	(3.63)	(3.75)
Mother's BMI	0.0972**	0.0939**	0.0676**	0.0642**
	(9.36)	(9.11)	(4.61)	(4.42)
Wave				
1993	0.242**	0.246**	0.253	0.254
	(2.27)	(2.31)	(1.57)	(1.57)
1997	0.205*	0.205*	0.303*	0.309*
	0.273**	0.278**	0.358*	0.366*
2000	-2.2	-2.24	-1.83	-1.88
	0.571**	0.570**	0.467**	0.481**
2004	-4.14	-4.12	-2.09	-2.15
	0.452**	0.455**	0.617**	0.642**
2006	-3	-2.99	-2.79	-2.89
	0.530**	0.506**	0.541**	0.574**
2009	-3.61	-3.3	-2.45	-2.52
	0.788**	0.746**	1.309**	1.349**
2011	-5.48	-4.74	-6.75	-6.45
Province				
Liaoning	0.0608	-0.0556	0.602*	0.421
	(0.23)	(-0.21)	(1.76)	(1.26)
Heilongjiang	-0.0029	-0.126	0.247	0.0649
	(-0.01)	(-0.48)	(0.70)	(0.19)
Shanghai	0.363	0.241	0.635*	0.59

	(1.22)	(0.81)	(1.71)	(1.57)
Jiangsu	0.0673	-0.0689	0.114	-0.0563
	(0.26)	(-0.27)	(0.33)	(-0.16)
Shandong	0.808**	0.678**	1.153**	0.960**
	(3.14)	(2.69)	(3.45)	(2.95)
Henan	(0.20)	(0.32)	-0.0112	-0.209
	(-0.74)	(-1.23)	(-0.03)	(-0.60)
Hubei	-0.532**	-0.671**	-0.289	-0.497
	(-1.97)	(-2.54)	(-0.79)	(-1.40)
Hunan	0.0294	-0.105	0.536	0.354
	(0.11)	(-0.40)	(1.56)	(1.06)
Guangxi	-0.881**	-1.026**	-0.910**	-1.116**
	(-3.27)	(-3.90)	(-2.45)	(-3.09)
Guizhou	-0.691**	-0.831**	-0.485	-0.669*
	(-2.56)	(-3.15)	(-1.33)	(-1.89)
Chongqing	-0.0121	-0.121	0.401	0.237
	(-0.03)	(-0.34)	(0.92)	(0.55)
Constant	-5.818**	-5.647**	-5.715**	-5.604**
	(-13.41)	(-13.31)	(-9.48)	(-9.54)
N	12311	12311	12311	12311

Table A8: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity for Males, CHNS, 1991-2011 (Table 2.7)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-0.427	-0.660*	-0.00852**	-0.0123**	-0.0109**	-0.0117**
	(-1.22)	(-1.65)	(-2.25)	(-2.84)	(-4.09)	(-3.83)
Child's Age-Square	-0.0332**	-0.0295*	-0.000154	-9.39E-05	0.000153	0.000166
	(-1.98)	(-1.73)	(-0.85)	(-0.51)	(1.19)	(1.27)
SES: Education Level						
Middle/High School	1.308	-1.12	-0.00221	-0.0418*	-0.0105	-0.0214
	(1.56)	(-0.52)	(-0.24)	(-1.80)	(-1.64)	(-1.30)
College and Above	7.088**	5.556	0.0434**	0.0237	0.00957	0.0437
	(4.04)	(1.37)	(2.29)	(0.54)	(0.72)	(1.41)
Child's Age * SES						
*Age*Middle/High School*		0.22		0.00359*		0.00104
		(1.23)		(1.85)		(0.76)
*Age*College and Above*		0.13		0.0016		-0.00338
		(0.37)		(0.42)		(-1.27)
Urban Status	2.846**	2.855**	0.0298**	0.0300**	-0.000241	0.00
	(3.57)	(3.58)	(3.47)	(3.49)	(-0.04)	0.00
Father's BMI	1.043**	1.042**	0.00618**	0.00618**	0.00280**	0.00284**
	(10.34)	(10.33)	(5.67)	(5.66)	(3.63)	(3.68)
Mother's BMI	1.587**	1.584**	0.0108**	0.0108**	0.00496**	0.00499**
	(13.26)	(13.22)	(8.35)	(8.31)	(5.42)	(5.45)
Wave						
1993	2.321**	2.338**	0.0185*	0.0187*	0.0034	0.00339
	(2.25)	(2.26)	(1.65)	(1.68)	(0.43)	(0.43)
1997	1.61	1.558	0.0196	0.0187	0.0132	0.0125
	(1.43)	(1.39)	(1.62)	(1.54)	(1.54)	(1.45)
2000	0.659	0.586	0.0209	0.0196	0.0108	0.00975
	(0.54)	(0.48)	(1.59)	(1.49)	(1.16)	(1.05)
2004	3.458**	3.348**	0.0350**	0.0331**	0.00714	0.00583
	(2.36)	(2.28)	(2.21)	(2.09)	(0.64)	(0.52)
2006	2.631	2.542	0.0543**	0.0528**	0.0378**	0.0369**
	(1.63)	(1.57)	(3.11)	(3.02)	(3.07)	(2.99)
2009	0.345	0.286	0.0496**	0.0485**	0.0295**	0.0285**
	(0.21)	(0.18)	(2.85)	(2.79)	(2.40)	(2.31)
2011	2.963*	2.927*	0.0944**	0.0937**	0.0879**	0.0869**

	(1.72)	(1.70)	(5.06)	(5.02)	(6.68)	(6.60)
Province						
Liaoning	-11.64**	-11.66**	-0.0527	-0.0528	0.0285	0.0306
	(-3.10)	(-3.10)	(-1.30)	(-1.30)	(0.99)	(1.06)
Heilongjiang	-9.033**	-9.021**	-0.0562	-0.0557	0.00257	0.00551
	(-2.40)	(-2.39)	(-1.38)	(-1.37)	(0.09)	(0.19)
Shanghai	-1.408	-1.451	0.0355	0.0348	0.05	0.05
	(-0.30)	(-0.31)	(0.71)	(0.69)	(1.45)	(1.45)
Jiangsu	-9.148**	-9.108**	-0.0477	-0.0468	0.00176	0.004
	(-2.46)	(-2.45)	(-1.19)	(-1.16)	(0.06)	(0.14)
Shandong	-1.623	-1.615	0.06	0.06	0.0768**	0.0790**
	(-0.43)	(-0.43)	(1.40)	(1.41)	(2.69)	(2.77)
Henan	-11.10**	-11.05**	-0.0776*	-0.0763*	-0.00132	0.00206
	(-2.98)	(-2.96)	(-1.93)	(-1.89)	(-0.05)	(0.07)
Hubei	-18.92**	-18.87**	-0.0955**	-0.0944**	-0.00868	-0.00606
	(-5.08)	(-5.06)	(-2.37)	(-2.34)	(-0.31)	(-0.21)
Hunan	-12.18**	-12.13**	-0.0636	-0.0625	0.0108	0.0133
	(-3.27)	(-3.26)	(-1.58)	(-1.55)	(0.38)	(0.47)
Guangxi	-22.04**	-22.04**	-0.112**	-0.112**	-0.0201	-0.0175
	(-6.01)	(-6.00)	(-2.82)	(-2.81)	(-0.72)	(-0.62)
Guizhou	-16.91**	-16.86**	-0.107**	-0.106**	-0.0148	-0.0122
	(-4.59)	(-4.57)	(-2.68)	(-2.64)	(-0.53)	(-0.43)
Chongqing	-2.885	-2.986	0.0149	0.0136	0.0738*	0.0760*
	(-0.50)	(-0.52)	(0.24)	(0.22)	(1.69)	(1.74)
Constant	0.233	2.451	-0.131**	-0.0959	-0.0447	-0.0415
	(0.05)	(0.45)	(-2.39)	(-1.63)	(-1.15)	(-1.00)
N	6591	6591	6591	6591	6591	6591

Table A9: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity for Females, CHNS, 1991-2011 (Table 2.7 Cont'd)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-3.603**	-2.952**	-0.0181**	-0.0167**	-0.0133**	-0.0125**
	(-9.95)	(-6.95)	(-4.87)	(-3.83)	(-5.74)	(-4.58)
Child's Age-Square	0.141**	0.129**	0.000306*	0.000285	0.000329**	0.000318**
	(8.07)	(7.22)	(1.71)	(1.55)	(2.94)	(2.77)
SES: Education Level						
Middle/High School	-2.408**	3.940*	-0.0111	0.000305	-0.00861	-0.00306
	(-2.75)	(1.68)	(-1.23)	(0.01)	(-1.53)	(-0.20)
College and Above	2.008	8.033**	0.0337*	0.0821**	0.0198*	0.0716**
	(1.17)	(1.99)	(1.91)	(1.98)	(1.79)	(2.76)
Child's Age * SES						
*Age*Middle/High School*		-0.558**		-0.00094		-0.000414
		(-2.91)		(-0.48)		(-0.34)
*Age*College and Above*		-0.527		-0.00454		-0.00491**
		(-1.54)		(-1.29)		(-2.24)
Urban Status	1.33	1.31	0.0138*	0.01	0.01	0.01
	(1.64)	(1.62)	(1.65)	(1.64)	(1.37)	(1.35)
Father's BMI	1.569**	1.575**	0.00867**	0.00865**	0.00409**	0.00406**
	(11.73)	(11.78)	(6.31)	(6.30)	(4.77)	(4.74)
Mother's BMI	1.535**	1.545**	0.00659**	0.00661**	0.000555	0.00057
	(12.48)	(12.57)	(5.22)	(5.24)	(0.70)	(0.72)
Wave						
1993	0.707	0.686	0.0103	0.0101	0.0103	0.0101
	(0.68)	(0.66)	(0.96)	(0.95)	(1.54)	(1.52)
1997	0.0102	0.124	0.00626	0.00609	0.00321	0.00284
	(0.01)	(0.11)	(0.53)	(0.52)	(0.44)	(0.39)
2000	-0.364	-0.164	0.0086	0.00855	0.00328	0.00294
	(-0.29)	(-0.13)	(0.68)	(0.67)	(0.41)	(0.37)
2004	1.803	2.116	0.0442**	0.0445**	0.0143	0.0142
	(1.19)	(1.40)	(2.85)	(2.86)	(1.47)	(1.46)
2006	-2.166	-1.914	0.00485	0.00498	-0.00214	-0.00231
	(-1.29)	(-1.14)	(0.28)	(0.29)	(-0.20)	(-0.22)
2009	-2.431	-2.249	0.0337*	0.0340*	-0.0021	-0.00195
	(-1.35)	(-1.25)	(1.82)	(1.83)	(-0.18)	(-0.17)
2011	1.325	1.423	0.0620**	0.0622**	0.0482**	0.0483**
	(0.72)	(0.78)	(3.30)	(3.31)	(4.11)	(4.12)
Province						
Liaoning	-7.328*	-7.346*	-0.0187	-0.0147	-0.0123	-0.00734

	(-1.76)	(-1.76)	(-0.44)	(-0.34)	(-0.46)	(-0.27)
Heilongjiang	-4.969	-5.019	-0.0284	-0.0243	-0.0199	-0.0147
	(-1.18)	(-1.19)	(-0.66)	(-0.56)	(-0.74)	(-0.54)
Shanghai	1.534	1.615	0.0301	0.0307	0.04	0.04
	(0.31)	(0.33)	(0.59)	(0.61)	(1.40)	(1.42)
Jiangsu	-3.666	-3.714	-0.0258	-0.0226	-0.0255	-0.0215
	(-0.88)	(-0.89)	(-0.60)	(-0.53)	(-0.95)	(-0.80)
Shandong	3.879	3.775	0.06	0.06	0.01	0.01
	(0.92)	(0.90)	(1.29)	(1.36)	(0.20)	(0.35)
Henan	-7.090*	-7.195*	-0.0377	-0.0342	-0.0329	-0.0285
	(-1.70)	(-1.72)	(-0.88)	(-0.80)	(-1.23)	(-1.06)
Hubei	-13.10**	-13.20**	-0.0609	-0.0573	-0.0324	-0.0278
	(-3.15)	(-3.17)	(-1.43)	(-1.34)	(-1.22)	(-1.04)
Hunan	-5.716	-5.792	-0.0133	-0.01	0.00247	0.0067
	(-1.36)	(-1.38)	(-0.31)	(-0.23)	(0.09)	(0.25)
Guangxi	-13.89**	-13.90**	-0.0685	-0.0649	-0.042	-0.0376
	(-3.36)	(-3.35)	(-1.61)	(-1.52)	(-1.58)	(-1.41)
Guizhou	-9.602**	-9.693**	-0.0566	-0.053	-0.0306	-0.026
	(-2.32)	(-2.34)	(-1.33)	(-1.24)	(-1.15)	(-0.98)
Chongqing	-11.61**	-11.54**	-0.0461	-0.0434	-0.0104	-0.00724
	(-2.20)	(-2.18)	(-0.85)	(-0.80)	(-0.31)	(-0.21)
Constant	-1.512	-7.85	-0.0868	-0.104	0.0401	0.0277
	(-0.26)	(-1.28)	(-1.47)	(-1.64)	(1.09)	(0.70)
N	5720	5720	5720	5720	5720	5720

Table A10: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity for Urban, CHNS, 1991-2011 (Table 2.8)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-0.383	0.109	-0.00406	-0.0033	-0.00689*	-0.00413
	(-0.78)	(0.18)	(-0.73)	(-0.48)	(-1.90)	(-0.92)
Child's Age-Square	-0.0285	-0.0349	-0.000381	-0.000388	-1.55E-05	-5.01E-05
	(-1.22)	(-1.47)	(-1.43)	(-1.43)	(-0.09)	(-0.28)
SES: Education Level						
Middle/High School	1.742	6.288	0.0179	0.0159	-0.00671	0.0123
	(1.25)	(1.58)	(1.13)	(0.35)	(-0.65)	(0.42)
College and Above	5.604**	13.40**	0.0624**	0.122**	0.0084	0.0861**
	(2.94)	(2.75)	(2.88)	(2.20)	(0.59)	(2.39)
Child's Age * SES						
*Age*Middle/High School*		-0.366		0.000399		-0.00136
		(-1.17)		(0.11)		(-0.59)
*Age*College and Above*		-0.676*		-0.00547		-0.00697**
		(-1.74)		(-1.24)		(-2.42)
Male	2.051**	2.089**	0.0382**	0.0387**	0.0124*	0.0129*
	(2.16)	(2.20)	(3.54)	(3.58)	(1.77)	(1.83)
Father's BMI	1.783**	1.797**	0.0134**	0.0134**	0.00873**	0.00883**
	(10.22)	(10.29)	(6.74)	(6.76)	(6.75)	(6.82)
Mother's BMI	1.225**	1.232**	0.00890**	0.00888**	0.00154	0.00156
	(7.40)	(7.43)	(4.72)	(4.71)	(1.26)	(1.27)
Wave						
1993	1.162	1.11	-0.00163	-0.00218	0.00139	0.000757
	(0.78)	(0.74)	(-0.10)	(-0.13)	(0.12)	(0.07)
1997	2.001	1.989	0.0234	0.0219	0.00822	0.00705
	(1.27)	(1.26)	(1.31)	(1.22)	(0.71)	(0.60)
2000	2.816	2.814	0.0178	0.0155	0.0161	0.0144
	-1.62	-1.61	(0.90)	(0.78)	(1.25)	(1.12)
2004	3.278	3.33	0.0354	0.0336	-0.00136	-0.00244
	(1.56)	(1.58)	(1.49)	(1.41)	(-0.09)	(-0.16)
2006	-0.855	-0.816	0.0206	0.019	0.0125	0.0115
	(-0.37)	(-0.36)	(0.79)	(0.73)	(0.73)	(0.68)
2009	4.347*	4.306*	0.0732**	0.0701**	0.0447**	0.0424**
	-1.8	-1.77	(2.66)	(2.54)	(2.49)	(2.36)

2011	1.209	1.202	0.0627**	0.0607**	0.0568**	0.0554**
	(0.50)	(0.49)	(2.27)	(2.19)	(3.15)	(3.07)
Province						
Liaoning	-12.52**	-12.11**	-0.0413	-0.0357	-0.00946	-0.00369
	(-3.13)	(-3.02)	(-0.91)	(-0.78)	(-0.32)	(-0.12)
Heilongjiang	-12.73**	-12.35**	-0.0728	-0.0666	-0.0474	-0.0412
	(-3.17)	(-3.06)	(-1.59)	(-1.45)	(-1.59)	(-1.38)
Shanghai	-3.905	-3.632	-0.0121	-0.00859	(0.01)	(0.01)
	(-0.88)	(-0.82)	(-0.24)	(-0.17)	(-0.42)	(-0.31)
Jiangsu	-11.14**	-10.92**	-0.0898**	-0.0857*	-0.0688**	-0.0649**
	(-2.80)	(-2.74)	(-1.98)	(-1.89)	(-2.33)	(-2.20)
Shandong	-2.978	-2.679	0.03	0.04	0.00	0.01
	(-0.73)	(-0.66)	(0.75)	(0.85)	(0.05)	(0.20)
Henan	-13.63**	-13.19**	-0.107**	-0.0998**	-0.0621**	-0.0552*
	(-3.43)	(-3.31)	(-2.36)	(-2.20)	(-2.11)	(-1.87)
Hubei	-18.34**	-18.06**	-0.0765*	-0.0711	-0.0528*	-0.0477
	(-4.65)	(-4.56)	(-1.71)	(-1.58)	(-1.80)	(-1.63)
Hunan	-11.38**	-10.99**	-0.0867*	-0.0821*	-0.0476	-0.0425
	(-2.84)	(-2.73)	(-1.90)	(-1.80)	(-1.60)	(-1.43)
Guangxi	-20.43**	-20.01**	-0.103**	-0.0966**	-0.0673**	-0.0611**
	(-5.22)	(-5.10)	(-2.31)	(-2.16)	(-2.32)	(-2.10)
Guizhou	-15.14**	-14.69**	-0.113**	-0.107**	-0.0530*	-0.0467
	(-3.92)	(-3.79)	(-2.57)	(-2.43)	(-1.85)	(-1.63)
Chongqing	-10.04*	-9.891*	-0.111*	-0.107*	-0.0743*	-0.0708*
	(-1.79)	(-1.76)	(-1.74)	(-1.67)	(-1.78)	(-1.70)
Constant	-8.543	-14.40*	-0.276**	-0.290**	-0.0819	-0.118**
	(-1.27)	(-1.83)	(-3.61)	(-3.25)	(-1.64)	(-2.03)
N	3405	3405	3405	3405	3405	3405

Table A11: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity for Rural, CHNS, 1991-2011 (Table 2.8 Cont'd)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-2.466**	-2.328**	-0.0158**	-0.0174**	-0.0137**	-0.0141**
	(-8.36)	(-6.91)	(-5.27)	(-5.07)	(-6.68)	(-6.01)
Child's Age-Square	0.0764**	0.0739**	0.000201	0.00023	0.000316**	0.000324**
	(5.37)	(5.08)	(1.39)	(1.55)	(3.19)	(3.19)
SES: Education Level						
Middle/High School	-0.951	0.617	-0.0109	-0.0255	-0.0104**	-0.0151
	(-1.41)	(0.35)	(-1.59)	(-1.43)	(-2.22)	(-1.24)
College and Above	4.823**	(0.43)	0.02	(0.02)	0.015	0.04
	(2.47)	(-0.09)	(1.03)	(-0.40)	(1.10)	(1.13)
Child's Age * SES						
*Age*Middle/High School*		-0.147		0.00131		0.000442
		(-1.00)		(0.88)		(0.43)
*Age*College and Above*		0.549		0.00384		-0.00218
		(1.32)		(0.90)		(-0.75)
Male	0.20	0.22	0.0178**	0.0177**	0.0206**	0.0205**
	(0.35)	(0.38)	(3.06)	(3.05)	(5.17)	(5.15)
Father's BMI	1.063**	1.062**	0.00520**	0.00520**	0.00174**	0.00174**
	(11.75)	(11.75)	(5.65)	(5.65)	(2.75)	(2.75)
Mother's BMI	1.674**	1.672**	0.00880**	0.00876**	0.00334**	0.00335**
	(16.60)	(16.58)	(8.56)	(8.52)	(4.75)	(4.76)
Wave						
1993	1.506*	1.500*	0.0198**	0.0199**	0.00771	0.00772
	(1.78)	(1.78)	(2.30)	(2.31)	(1.31)	(1.31)
1997	0.39	0.465	0.00928	0.00918	0.00816	0.00791
	(0.42)	(0.50)	(0.97)	(0.96)	(1.25)	(1.21)
2000	-0.844	-0.758	0.0145	0.0143	0.00372	0.00343
	(-0.84)	(-0.75)	(1.42)	(1.40)	(0.53)	(0.49)
2004	2.318*	2.453**	0.0420**	0.0415**	0.0154*	0.0149*
	(1.90)	(2.00)	(3.38)	(3.33)	(1.80)	(1.75)
2006	1.016	1.131	0.0379**	0.0376**	0.0223**	0.0219**
	-0.75	-0.83	(2.75)	(2.72)	(2.36)	(2.32)
2009	-2.615*	-2.585*	0.0343**	0.0340**	0.00707	0.00698
	(-1.89)	(-1.87)	(2.43)	(2.41)	(0.73)	(0.72)

2011	2.675*	2.708*	0.0898**	0.0898**	0.0778**	0.0777**
	(1.82)	(1.84)	(6.00)	(6.00)	(7.59)	(7.58)
Province						
Liaoning	-7.597*	-7.818*	0.00028	-0.000898	0.0736**	0.0744**
	(-1.66)	(-1.71)	(0.01)	(-0.02)	(2.31)	(2.33)
Heilongjiang	-3.607	-3.89	0.00261	0.00131	0.0648**	0.0658**
	(-0.79)	(-0.85)	(0.06)	(0.03)	(2.03)	(2.06)
Shanghai	4.969	5.586	0.102*	0.104*	0.149**	0.147**
	(0.90)	(1.01)	(1.81)	(1.85)	(3.88)	(3.82)
Jiangsu	-3.811	-3.996	0.0152	0.0145	0.0654**	0.0662**
	(-0.84)	(-0.88)	(0.33)	(0.31)	(2.06)	(2.08)
Shandong	3.628	3.435	0.100**	0.0993**	0.115**	0.116**
	(0.80)	(0.75)	(2.15)	(2.14)	(3.63)	(3.65)
Henan	(6.46)	(6.69)	-0.00869	-0.00936	0.0572*	0.0580*
	(-1.42)	(-1.47)	(-0.19)	(-0.20)	(1.80)	(1.82)
Hubei	-14.30**	-14.53**	-0.0457	-0.0464	0.0484	0.0493
	(-3.14)	(-3.19)	(-0.99)	(-1.00)	(1.53)	(1.55)
Hunan	-7.418	-7.643*	0.00912	0.00857	0.0829**	0.0837**
	(-1.63)	(-1.68)	(0.20)	(0.18)	(2.61)	(2.63)
Guangxi	-16.32**	-16.53**	-0.0517	-0.0528	0.0412	0.042
	(-3.61)	(-3.65)	(-1.12)	(-1.15)	(1.30)	(1.33)
Guizhou	-12.01**	-12.26**	-0.0354	-0.0361	0.0462	0.0471
	(-2.65)	(-2.70)	(-0.76)	(-0.78)	(1.46)	(1.49)
Chongqing	(8.05)	(8.17)	0.0532	0.0511	0.131**	0.131**
	(-1.40)	(-1.42)	(0.91)	(0.87)	(3.25)	(3.27)
Constant	2.393	1.42	-0.102*	-0.0867	-0.0528	-0.0503
	(0.44)	(0.25)	(-1.84)	(-1.50)	(-1.38)	(-1.27)
N	8906	8906	8906	8906	8906	8906

Table A12: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity in 1990', CHNS (Table 2.9)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	-3.343**	-3.400**	-0.0191**	-0.0238**	-0.0133**	-0.0157**
	(-10.74)	(-9.38)	(-6.17)	(-6.61)	(-6.61)	(-6.67)
Child's Age-Square	0.113**	0.115**	0.000376**	0.000489**	0.000337**	0.000395**
	(7.56)	(7.40)	(2.53)	(3.16)	(3.47)	(3.92)
SES: Education Level						
Middle/High School	-1.790**	-2.339	-0.00536	-0.0487**	-0.00810*	-0.0298**
	(-2.54)	(-1.27)	(-0.76)	(-2.67)	(-1.77)	(-2.50)
College and Above	0.572	4.67	0.03	0.06	0.00488	0.04
	(0.30)	(1.00)	(1.47)	(1.34)	(0.40)	(1.28)
Child's Age * SES						
*Age*Middle/High School*		0.054		0.00399**		0.00201**
		(0.35)		(2.61)		(2.01)
*Age*College and Above*		-0.389		-0.00352		-0.00333
		(-0.98)		(-0.90)		(-1.30)
Male	-0.147	-0.137	0.0146**	0.0145**	0.0106**	0.0106**
	(-0.24)	(-0.23)	(2.43)	(2.42)	(2.70)	(2.70)
Urban Status	1.405**	1.414**	0.0172**	0.0177**	0.000611	0.000905
	(1.97)	(1.98)	(2.42)	(2.50)	(0.13)	(0.20)
Father's BMI	1.634**	1.636**	0.00673**	0.00671**	0.00231**	0.00231**
	(12.60)	(12.61)	(5.22)	(5.21)	(2.74)	(2.75)
Mother's BMI	1.529**	1.529**	0.00737**	0.00728**	0.00213**	0.00209**
	(13.33)	(13.32)	(6.47)	(6.40)	(2.86)	(2.81)
Wave						
1993	1.687**	1.682**	0.0160**	0.0161**	0.00747	0.00749
	(2.37)	(2.36)	(2.26)	(2.27)	(1.61)	(1.62)
1997	1.578*	1.538*	0.0178**	0.0165**	0.0106**	0.00979*
	(1.93)	(1.88)	(2.20)	(2.03)	(2.00)	(1.85)
Province						
Heilongjiang	0.87	0.88	-0.0119	-0.012	-0.0195	-0.0195
	(0.43)	(0.43)	(-0.58)	(-0.59)	(-1.47)	(-1.47)
Jiangsu	2.707*	2.706*	0.00615	0.00637	-0.0123	-0.0122
	(1.87)	(1.87)	(0.43)	(0.44)	(-1.31)	(-1.31)
Shandong	10.57**	10.57**	0.0930**	0.0934**	0.0372**	0.0373**

	(7.15)	(7.15)	(6.34)	(6.36)	(3.88)	(3.89)
Henan	-0.464	-0.397	-0.0262*	-0.0245*	-0.0240**	-0.0230**
	(-0.33)	(-0.28)	(-1.85)	(-1.73)	(-2.60)	(-2.48)
Hubei	-6.137**	-6.089**	-0.0371**	-0.0355**	-0.0219**	-0.0209**
	(-4.49)	(-4.45)	(-2.73)	(-2.61)	(-2.47)	(-2.36)
Hunan	2.10	2.14	0.01	0.01	0.00237	0.00312
	(1.50)	(1.53)	(0.82)	(0.91)	(0.26)	(0.34)
Guangxi	-6.487**	-6.467**	-0.0392**	-0.0384**	-0.0296**	-0.0291**
	(-4.68)	(-4.66)	(-2.85)	(-2.79)	(-3.29)	(-3.24)
Guizhou	-3.475**	-3.454**	-0.0271**	-0.0266*	-0.0198**	-0.0195**
	(-2.54)	(-2.52)	(-2.00)	(-1.96)	(-2.23)	(-2.20)
Constant	-10.01**	-9.677**	-0.0958**	-0.0562	0.0325	0.0516*
	(-2.54)	(-2.26)	(-2.45)	(-1.32)	(1.27)	(1.85)
N	7481	7481	7481	7481	7481	7481

Table A13: Full Set of OLS Estimates of Effects of SES (Education Level) on Children's BMI, Overweight Status and Obesity in 2000', CHNS (Table 2.9 Cont'd)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI	BMI	Overweight	Overweight	Obesity	Obesity
Child's Age	0.271	0.706	-0.00365	-0.00193	-0.00984**	-0.00818**
	(0.64)	(1.40)	(-0.75)	(-0.34)	(-2.93)	(-2.06)
Child's Age-Square	-0.0540**	-0.0570**	-0.000434*	-0.000446*	5.79E-05	3.86E-05
	(-2.64)	(-2.77)	(-1.87)	(-1.91)	(0.36)	(0.24)
SES: Education Level						
Middle/High School	2.425**	7.378**	-0.00352	0.0154	-0.00661	0.00595
	(2.04)	(2.28)	(-0.26)	(0.42)	(-0.70)	(0.23)
College and Above	8.649**	13.01**	0.0487**	0.07	0.0238*	0.0681**
	(4.79)	(2.99)	(2.37)	(1.38)	(1.66)	(1.98)
Child's Age * SES						
*Age*Middle/High School*		-0.44		-0.00168		-0.00108
		(-1.64)		(-0.55)		(-0.51)
*Age*College and Above*		-0.383		-0.00177		-0.00422
		(-1.04)		(-0.42)		(-1.44)
Male	2.022**	2.011**	0.0357**	0.0356**	0.0305**	0.0304**
	(2.47)	(2.46)	(3.85)	(3.84)	(4.73)	(4.70)
Urban Status	2.822**	2.851**	0.0311**	0.0313**	0.01	0.01
	(2.99)	(3.02)	(2.90)	(2.91)	(1.34)	(1.36)
Father's BMI	1.008**	1.009**	0.00713**	0.00713**	0.00373**	0.00375**
	(9.62)	(9.63)	(5.99)	(5.99)	(4.51)	(4.53)
Mother's BMI	1.561**	1.566**	0.0103**	0.0103**	0.00375**	0.00379**
	(11.94)	(11.97)	(6.93)	(6.94)	(3.63)	(3.67)
Wave						
2004	2.768**	2.842**	0.0262**	0.0264**	0.00375	0.004
	(2.38)	(2.44)	(1.98)	(2.00)	(0.41)	(0.43)
2006	0.723	0.78	0.0194	0.0196	0.0119	0.0123
	(0.57)	(0.61)	(1.34)	(1.35)	(1.18)	(1.22)
2009	-0.6	-0.581	0.0270*	0.0271*	0.00701	0.00738
	(-0.46)	(-0.44)	(1.80)	(1.81)	(0.67)	(0.71)
2011	2.758**	2.731**	0.0654**	0.0654**	0.0611**	0.0614**
	(2.00)	(1.98)	(4.19)	(4.18)	(5.62)	(5.65)
Province						
Liaoning	-8.748**	-8.757**	-0.0163	-0.0161	0.0299	0.0323
	(-2.83)	(-2.83)	(-0.46)	(-0.46)	(1.22)	(1.32)
Heilongjiang	-5.849*	-5.899*	-0.0304	-0.0303	0.00648	0.0092
	(-1.93)	(-1.94)	(-0.88)	(-0.88)	(0.27)	(0.38)
Shanghai	0.358	0.401	0.0373	0.0374	0.0537*	0.0538*

	(0.10)	(0.11)	(0.93)	(0.93)	(1.92)	(1.93)
Jiangsu	-5.358*	-5.449*	-0.0301	-0.0303	-0.00586	-0.00445
	(-1.73)	(-1.75)	(-0.85)	(-0.86)	(-0.24)	(-0.18)
Shandong	2.036	2.003	0.0785**	0.0786**	0.0584**	0.0603**
	(0.65)	(0.64)	(2.21)	(2.20)	(2.36)	(2.43)
Henan	-6.029*	-6.080*	(0.02)	(0.02)	0.00496	0.00736
	(-1.90)	(-1.91)	(-0.66)	(-0.66)	(0.20)	(0.29)
Hubei	-15.89**	-15.89**	-0.0665*	-0.0663*	-0.0145	-0.0124
	(-5.05)	(-5.04)	(-1.86)	(-1.85)	(-0.58)	(-0.50)
Hunan	-11.47**	-11.51**	-0.0484	-0.0484	0.0193	0.0209
	(-3.60)	(-3.61)	(-1.34)	(-1.34)	(0.77)	(0.83)
Guangxi	-19.75**	-19.61**	-0.0978**	-0.0970**	-0.0291	-0.0262
	(-6.57)	(-6.50)	(-2.86)	(-2.83)	(-1.23)	(-1.10)
Guizhou	-13.12**	-13.25**	-0.0978**	-0.0981**	-0.0248	-0.0225
	(-4.32)	(-4.35)	(-2.84)	(-2.84)	(-1.03)	(-0.94)
Chongqing	-8.227**	-8.043**	-0.0233	-0.0225	0.0299	0.0322
	(-2.03)	(-1.98)	(-0.51)	(-0.49)	(0.94)	(1.01)
Constant	-8.108	-12.75**	-0.190**	-0.209**	-0.0548	-0.0746
	(-1.56)	(-2.14)	(-3.22)	(-3.08)	(-1.34)	(-1.59)
N	4830	4830	4830	4830	4830	4830

Table A14: Full Set of Quantile Regression Results for BMI Percentile Ranking, Children Ages 2 to 18, CHNS, 1991-2011 (Table 4.10)

	(1)	(2)	(3)	(4)	(5)
	5%	25%	50%	75%	95%
Child's Age	0.13	-0.188	-2.492**	-3.483**	-1.834**
	(0.77)	(-0.52)	(-5.56)	(-7.44)	(-4.32)
Child's Age-Square	-0.00383	-0.0017	0.0844**	0.109**	0.0155
	(-0.53)	(-0.11)	(4.44)	(5.46)	(0.86)
SES: Education Level					
Middle/High School	0.264	0.16	3.282	2.824	-1.525
	(0.29)	(0.08)	(1.34)	(1.11)	(-0.66)
College and Above	1.336	7.412**	11.41**	10.54**	-3.889
	(0.80)	(2.08)	(2.59)	(2.29)	(-0.93)
Child's Age * SES					
*Age*Middle/High School*	-0.0335	-0.105	-0.284	-0.361*	0.143
	(-0.44)	(-0.64)	(-1.41)	(-1.71)	(0.75)
*Age*College and Above*	(0.03)	-0.336	-0.553	-0.622	0.605*
	(-0.20)	(-1.11)	(-1.47)	(-1.58)	(1.70)
Male	-0.593**	0.17	0.80	0.91	1.245*
	(-2.09)	(0.29)	(1.06)	(1.16)	(1.75)
Urban Status	0.31	1.336*	1.463*	3.053**	1.984**
	(0.94)	(1.89)	(1.67)	(3.34)	(2.39)
Father's BMI	0.183**	1.476**	2.073**	1.973**	0.963**
	(3.94)	(14.82)	(16.81)	(15.32)	(8.25)
Mother's BMI	0.250**	1.375**	2.134**	1.866**	0.568**
	(5.01)	(12.90)	(16.16)	(13.53)	(4.54)
Wave					
1993	-0.404	0.0854	1.331	2.581**	1.789*
	(-0.94)	(0.09)	(1.18)	(2.18)	(1.67)
1997	-0.474	0.604	0.918	1.912	2.177*
	(-1.01)	(0.60)	(0.74)	(1.48)	(1.86)
2000	-0.0935	-1.107	-1.103	0.994	1.519
	(-0.18)	(-1.03)	(-0.82)	(0.71)	(1.20)
2004	0.518	0.123	2.217	5.202**	4.398**
	(0.84)	(0.09)	(1.36)	(3.07)	(2.86)
2006	-1	-3.515**	-0.108	3.671**	3.235*
	(-1.48)	(-2.43)	(-0.06)	(1.96)	(1.91)
2009	-0.638	-3.799**	-3.836**	3.599*	1.997
	(-0.91)	(-2.55)	(-2.08)	(1.87)	(1.14)
2011	-0.733	-4.864**	-0.527	9.357**	6.107**
	(-1.00)	(-3.12)	(-0.27)	(4.64)	(3.34)

Province					
Liaoning	-4.625**	-19.66**	-17.33**	-4.366	3.412
	(-2.85)	(-5.67)	(-4.03)	(-0.97)	(0.84)
Heilongjiang	-3.957**	-15.93**	-13.19**	-3.213	0.652
	(-2.42)	(-4.56)	(-3.05)	(-0.71)	(0.16)
Shanghai	-3.204	-6.331	0.672	0.513	1.96
	(-1.63)	(-1.51)	(0.13)	(0.09)	(0.40)
Jiangsu	-3.384**	-16.02**	-12.55**	-2.132	1.782
	(-2.10)	(-4.64)	(-2.94)	(-0.48)	(0.44)
Shandong	-0.545	-7.166**	(4.08)	5.89	7.913*
	(-0.34)	(-2.07)	(-0.95)	(1.31)	(1.94)
Henan	-3.543**	-16.62**	-15.38**	-7.610*	0.39
	(-2.19)	(-4.80)	(-3.59)	(-1.70)	(0.10)
Hubei	-4.846**	-23.74**	-25.14**	-15.22**	-0.612
	(-3.00)	(-6.88)	(-5.88)	(-3.41)	(-0.15)
Hunan	-4.521**	-18.62**	-15.74**	-6.061	2.665
	(-2.79)	(-5.38)	(-3.67)	(-1.35)	(0.66)
Guangxi	-4.896**	-23.04**	-26.32**	-18.55**	-7.207*
	(-3.06)	(-6.74)	(-6.22)	(-4.20)	(-1.80)
Guizhou	-4.420**	-19.99**	-20.81**	-12.02**	-2.718
	(-2.76)	(-5.84)	(-4.91)	(-2.71)	(-0.68)
Chongqing	-4.504**	-14.39**	-16.52**	-10.37*	1.263
	(-2.01)	(-3.01)	(-2.79)	(-1.68)	(0.23)
Constant	-3.768	-24.68**	-25.29**	1.67	66.66**
	(-1.59)	(-4.87)	(-4.03)	(0.25)	(11.21)
N	12311	12311	12311	12311	12311

Appendix B

ADDITIONAL ANALYSES RELATED TO CHAPTER THREE

B.1 : Robustness Check for OLS Estimate

Table B1: OLS Estimates of Effects on Children's BMI Ranking for the Full Sample (without Community Variables), CHNS, 2004-2011

	Coefficient	P>t
Mother's BMI	1.678	0.000
Father's BMI	0.782	0.000
Child's Age	1.473	0.006
Child's Age-Squared	-0.115	0.000
Male	2.740	0.009
Urban	1.307	0.278
SES: Education Level		
Middle/High School	5.342	0.001
College and Above	12.469	0.000
Wave		
2006	-1.528	0.299
2009	-3.569	0.020
2011	0.481	0.760
Province		
Liaoning	-6.390	0.061
Heilongjiang	-5.323	0.104
Shanghai	0.641	0.861
Jiangsu	-4.984	0.142
Shandong	1.133	0.739
Henan	-6.871	0.054
Hubei	-12.078	0.001
Hunan	-10.818	0.002
Guangxi	-21.074	0.000

Guizhou	-15.321	0.000
Chongqing	-7.733	0.065
Constant	-10.333	0.096
R-sqrd	0.166	

B.2 : Full Set of OLS Estimates

Table B2: Full Set of OLS Estimates of Effects on Children's BMI Ranking for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011 (Table 3.3)

	Full Sample	Urban	Rural
Mother's BMI	1.674**	1.405**	1.777**
	(10.35)	(4.58)	(9.32)
Father's BMI	0.764**	1.718**	0.591**
	(6.42)	(5.45)	(4.61)
Child's Age	1.467**	3.250**	0.667
	(2.76)	(3.33)	(1.06)
Child's Age-Square	-0.117**	-0.191**	-0.0853**
	(-4.50)	(-4.08)	(-2.75)
Male	2.725**	5.232**	1.687
	(2.60)	(2.74)	(1.35)
Urban Status	0.304		
	(0.25)		
SES: Education Level			
Middle/High School	4.708**	13.94**	2.91
	(2.88)	(3.42)	(1.63)
College and Above	10.36**	17.06**	11.39**
	(4.42)	(3.74)	(3.60)
% With Fast Food Restaurant	3.608**	1.007	5.934**
	(2.47)	(0.42)	(3.03)

% With Child Care for <3 yrs Children	4.559**	-1.788	8.178**
	(3.31)	(-0.64)	(4.89)
% With Child Care for 3-6 yrs Children	-0.709	4.619*	-3.647**
	(-0.54)	(1.72)	(-2.34)
Wave			
2006	-1.611	-3.187	-0.55
	(-1.09)	(-1.13)	(-0.32)
2009	-4.196**	0.0542	-6.533**
	(-2.73)	(0.02)	(-3.65)
2011	-0.247	-2.616	0.095
	(-0.16)	(-0.87)	(0.05)
Province			
Liaoning	-6.078*	-14.31**	0.92
	(-1.73)	(-2.56)	(0.17)
Heilongjiang	-4.761	-11.20**	0.122
	(-1.43)	(-2.19)	(0.02)
Shanghai	-0.465	-2.901	2.635
	(-0.13)	(-0.62)	(0.44)
Jiangsu	-5.768*	-7.446	-4.453
	(-1.70)	(-1.51)	(-0.84)
Shandong	1.996	-3.472	6.989
	(0.58)	(-0.67)	(1.32)
Henan	-6.149*	-13.02**	-0.304
	(-1.69)	(-2.25)	(-0.06)
Hubei	-12.99**	-14.29**	-10.20*
	(-3.65)	(-2.62)	(-1.91)
Hunan	-11.40**	-14.65**	-6.737
	(-3.14)	(-2.41)	(-1.26)
Guangxi	-22.07**	-21.78**	-19.07**
	(-6.70)	(-4.35)	(-3.75)
Guizhou	-15.38**	-18.51**	-11.83**
	(-4.59)	(-3.70)	(-2.29)
Chongqing	-8.396**	-9.481	-5.813
	(-1.98)	(-1.51)	(-0.93)
Constant	-9.679	-39.82**	-5.079
	(-1.56)	(-3.24)	(-0.64)
N	3102	944	2158
R-sqrd	0.172	0.195	0.179

B.3 : Checking for Extreme Values in the Urban Subsample

In this section, I report the results checking the urban data in details for the possible outliers. Firstly, I calculate the min, 1%, 10%, mean, 90%, 99%, max and standard deviation of child's BMI ranking for the whole data as well as the data grouped by SES for the urban population. I find that all the min and max are within 3 standard deviation of the mean, due to the large value of the standard deviation. The large standard deviation could make sense since the data distribute almost evenly across 0-100 BMI ranking.

Table B3: Descriptive Statistics for Child's BMI Ranking of the Urban Subsample, CHNS, 2004-2011

N	Min	1st Pctl	10th Pctl	Mean	90th Pctl	99th Pctl	Max	Std Dev
944	0.00	0.01	4.36	47.65	93.56	99.79	100.00	31.67

Table B4: Descriptive Statistics for Child's BMI Ranking of the Urban Subsample across SES Categories, CHNS, 2004-2011

Edu	N	Min	1st Pctl	10th Pctl	Mean	90th Pctl	99th Pctl	Max	Std Dev
Low	59	0.00	0.00	0.19	27.01	65.58	94.73	94.73	25.28
Mid	625	0.00	0.03	3.73	46.46	91.73	99.74	100.00	31.39
High	260	0.01	0.29	10.77	55.20	95.82	99.98	100.00	31.27

Secondly, I pull data for the cases where the BMI percentile is less than 1. In total, I have 42 out of the total 944 urban observations, with BMI percentile less than 1. Through close scrutiny, I find that they could all be valid observations, not data error. Here are some cases with BMI ranking number approaching zero. Case 1:

Male, Height (106.2cm), Weight (13kg), BMI (11.53). Case 2: Male, Height (120cm), Weight (17.5kg), BMI (12.15). They are underweight children, but these numbers are all within expectation, and are valid.

B.4 : Check for Measurement Error in Fixed-effects Model

In this section, I check for possible measurement error in the fixed-effects model. If I have the measurement error in the variables, it would still most likely exist in the fixed-effects model estimation, and the attenuation bias might be stronger than OLS estimation. Especially, if the underlying variable does not change much over time, but measurement error exists in each period, the bias could be very large.

The idea of testing the measurement error is to compare the coefficients of 1st difference estimators between short-time period and long-time period. The assumption is that if the measurement error exists, the attenuation bias in the longer period might be less. Therefore, if one see any difference in the coefficient estimates, one might think the measurement error exists.

Following this idea, here is how I test it for my study. I use 2006, 2009 and 2011 as a three-time period and restrict the tested sample containing the observations which appear fully in these three time-periods (e.g. every observation has full information in these three time periods).

1) Short-time period:

For these observations, I take the differences of the values of all the variables between 2006 and 2009 and saved them as new variables respectively. I run OLS regression using difference in child's BMI ranking as dependent variable, and the differences in each of the independent variables as predictors. The result could be found in the attached spreadsheet.

2) Long-time period:

Similarly, for these observations, I take the differences of the values of all the variables between 2006 and 2011 and saved them as new variables respectively. I run OLS regression using difference in child's BMI ranking as dependent variable, and the differences in each of the independent variables as predictors. The result could be found in the attached spreadsheet.

Table B5: OLS Regression Using First Difference Estimator (2006 vs. 2009), CHNS

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	4.80	30.72	0.16	0.88
difference in mother's BMI	2.68	2.26	1.19	0.24
difference in father's BMI	3.31	1.91	1.73	0.09
difference in child's age	1.20	11.38	0.11	0.92
difference in child's age-sq	-0.29	0.20	-1.44	0.15
difference in parental edu	33.04	9.78	3.38	0.00
difference in fastfood restaurant indicator	14.18	8.15	1.74	0.09
difference in childcare for <3 yr indicator	0.35	6.80	0.05	0.96
difference in childcare for 3-6 yr indicator	-13.57	9.24	-1.47	0.15

Table B6: OLS Regression Using First Difference Estimator (2006 vs. 2011), CHNS

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	7.57	50.95	0.15	0.88
difference in mother's BMI	3.22	2.29	1.41	0.16
difference in father's BMI	0.01	0.21	0.06	0.95
difference in child's age	-2.70	11.02	-0.24	0.81
difference in child's age-sq	0.05	0.13	0.38	0.71
difference in parental edu	11.06	9.72	1.14	0.26
difference in fastfood restaurant indicator	28.91	7.98	3.62	0.00
difference in childcare for <3 yr indicator	8.21	7.39	1.11	0.27
difference in childcare for 3-6 yr indicator	26.88	12.65	2.12	0.04

After comparing the coefficients for the short-time period and long-time period results, I could not conclude that the coefficients for each of the variable between these two results are the same, although I thought that it could be almost impossible to have the same coefficient estimates for each variable. Therefore, according to the test design mentioned above, I could have measurement error in the variables. In spite of this, I am thinking the test requirement for no measurement error is very strong, because it requires the same coefficient estimate for each variable for the two results.

Again, I take a close look at the time-variant variables I use for any possible sources of measurement error:

1) Mother's BMI: height and weight are collected through detailed physical examinations

2) Father's BMI: height and weight are collected through detailed physical examinations

3) Child's age: answered by adult if age<10

4) Parental education: answered by adult

5) Fast food restaurant in the community or not: information is collected from a knowledgeable respondent for this community

6) With private child care for <3yr children: information is collected from a knowledgeable respondent for this community

7) With private child care for 3-6 yr children: information is collected from a knowledgeable respondent for this community

I also check the quality control procedure for the survey and found that all the information in the survey was recorded to one's best, therefore any measurement error should have been minimized.

B.5 : Full Set of Random-effects Estimates

Table B7: Full Set of Random Effects Estimates on Children's BMI Ranking for the Full Sample, Urban Subsample and Rural Subsample, CHNS, 2004-2011 (Table 3.4)

	Full Sample	Urban	Rural
Mother's BMI	1.583**	1.390**	1.646**
	(9.05)	(4.26)	(7.94)
Father's BMI	0.590**	1.586**	0.465**
	(5.31)	(4.83)	(3.89)
Child's Age	1.140**	2.612**	0.499
	(2.21)	(2.82)	(0.81)
Child's Age-Square	-0.102**	-0.159**	-0.0790**
	(-4.07)	(-3.59)	(-2.61)
Male	2.512**	4.430**	1.631
	(2.16)	(2.11)	(1.17)
Urban Status	0.604		
	(0.45)		

SES: Education Level			
Middle/High School	4.836**	15.24**	2.766
	(2.83)	(3.57)	(1.48)
College and Above	8.677**	16.12**	9.880**
	(3.52)	(3.35)	(2.98)
With Fast Food Restaurant	2.583*	0.705	3.960**
	(1.82)	(0.31)	(2.10)
With Child Care for <3 yrs Children	3.705**	-2.030	6.595**
	(2.79)	(-0.78)	(4.07)
With Child Care for 3-6 yrs Children	-0.951	4.095	-2.949*
	(-0.74)	(1.60)	(-1.94)
Province			
Liaoning	-8.889**	-13.78**	-3.003
	(-2.55)	(-2.53)	(-0.57)
Heilongjiang	-7.352**	-10.86**	-2.868
	(-2.23)	(-2.22)	(-0.56)
Shanghai	-1.025	-3.760	2.468
	(-0.28)	(-0.80)	(0.41)
Jiangsu	-7.583**	-6.925	-6.134
	(-2.21)	(-1.42)	(-1.15)
Shandong	-0.693	-3.208	3.399
	(-0.20)	(-0.58)	(0.65)
Henan	-8.747**	-14.98**	-3.438
	(-2.42)	(-2.68)	(-0.64)
Hubei	-15.37**	-15.50**	-12.52**
	(-4.33)	(-2.77)	(-2.35)
Hunan	-13.38**	-14.86**	-9.461*
	(-3.71)	(-2.43)	(-1.77)
Guangxi	-24.95**	-22.71**	-22.35**
	(-7.65)	(-4.71)	(-4.40)
Guizhou	-18.01**	-17.71**	-14.98**
	(-5.42)	(-3.61)	(-2.90)
Chongqing	-9.526**	-10.45*	-7.076
	(-2.23)	(-1.67)	(-1.13)
Constant	0.016	-35.05**	3.896
	0.00	(-2.85)	(0.49)
N	3102	944	2158
R-sqrd	0.168	0.191	0.170