# Gender, Body Size, and the Prevalence of Obesity during China's Social and Economic Development

by

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ABSTRACT

The rate of obesity has increased noticeably in China since the 1980s, brought about by the "After Mao" revolution. This dissertation examines the social determinants of obesity and weight gain among men and women, using 1991-2009 waves of the longitudinal China Health and Nutrition Survey. The first study emphasizes that rapid technological adoption at home may also have the potential to lead to obesity epidemics. I hypothesize that adopting household technology is a factor in weight gain, independent from daily calorie consumption and energy expenditure in exercise. The results show household technology ownership and weight gain are linked, while changes in overall energy intake and exercise may not function as mediators for this relationship. Future public health policy may evaluate interventions that are focused on increasing low-intensity activities impacted by household technologies. My second study discusses whether obesity wage penalties seen in Western societies, such as wage reductions for obese individuals, are observed in modern China. The results indicate that obese women are not subject to wage penalties, while current male obesity rates may be worsened by heightened economic outcomes and greater social acceptance by customers and colleagues. With increasing interpersonal interactions in the workplace in Chinese industries, and the lack of public awareness of the risks of obesity, Chinese public health strategies for preventing and controlling obesity should target male non-manual laborers, the most vulnerable population in the future. The third study analyzes the impact of parental and own socioeconomic status on adult body weight and extends the research by estimating the influence of intergenerational social mobility on current body mass index. In the context of increasing social inequality in China, the study shows parental SES, own

SES, and social mobility to be negatively associated with body mass index among women; while respondent’s SES is positively associated with body mass index among men. The study results support the theory that parental SES has a more significant impact on current body weight for men and women after controlling social mobility; indicating that social mobility may function as a mediator for the relationship between parental SES and current body mass index.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

# CHAPTER 1

# INTRODUCTION

## *The Prevalence of Obesity and Its Health Risks*

There is strong evidence to indicate that obesity is increasing in most countries. Rising levels of overweight and obesity populations are a global trend (James, et.al, 2012; Devaux & Sassi, 2011). In 2008, more than 1.4 billion adults and 40 million children worldwide were overweight or obese, and the prevalence of obesity continues to increase in both developed and developing countries (World Health Organization [WHO], 2012). Most developing countries now suffer the burden of both overweight and underweight populations, and the prevalence of overweight is growing faster than underweight in both urban and rural areas (Mendez, Monteiro, & Popkin, 2005). The overweight/obese population has exceeded underweight in the world and most developing countries (Mendez, et al., 2005; Yach, Stuckler & Brownell, 2006).

Obesity has been found to be an independent risk factor for many health conditions and is associated with increased hazard ratios for mortality (Adams, et al., 2006; Berrington de Gonzalez, et al., 2010). The relationship between obesity and the risks of hypertension, coronary heart disease, and type two diabetes are well-recognized (Li, et al., 2002). Globally, 44% of diabetes, 23% of ischemic heart disease, and 7–41% of certain cancers are attributable to overweight and obesity (WHO, 2010). In addition, obese people have a greater risk of depression, low self-esteem, and poor body image as well as social prejudice, bias, discrimination, stereotype, and stigma. As a result, the number of studies linked to obesity has grown in popularity as a subject of study in response to this 21st century urgent public health threat (Cawley, 2014). Researchers believe that the increasing prevalence of overweight and obesity in societies is largely attributed to an increase in the population adopting riskier health lifestyles; including Westernized diet, sedentary routines, and technology use.

There are decades of social science research documenting obesity; however, most studies have been conducted in Western cultural contexts (Wang & Beydoun, 2007); with limited understanding of the nature of social determinants on obesity in developing worlds (Monteiro, et al., 2004). Many important questions still remain unexplained in non-Western contexts and deserve more through study.

*The Nutrition Transition in Modern Societies*

Omran's epidemiological transition predicts that modern society is moving from a pattern of high prevalence of infectious disease to chronic degenerative diseases (Omran, 2005). The concept of epidemiological transition is embodied by the theory of the demographic transition. Demographic transition theory postulates that a pattern of high fertility and mortality shifts to one of low fertility and mortality. Omran's theory focuses on changes in the pattern of disease and cause of mortality, while Popkin (1998) argues that the change from an earlier stage of pestilence, famine, and poor environmental sanitation to the later stage of chronic and degenerative disease is strongly associated with an individual's life-style. Popkin further extends Omran's theory to include the concept of "nutrition transition." Nutrition transition addresses the rapid changes in diet and physical activity level that come after a broad range of socioeconomic and demographic shifts worldwide (Popkin, 1998).

The theory of nutrition transition predicts an increase in obesity and its related chronic and degenerative diseases at the "final stage" of Omran's transition theory. This increase in obesity and related diseases has been observed in rich and middle-income countries; in addition, this trend has recently been discovered to be occurring in emerging countries thought to be poor. In both developed and developing countries, diet, activity, and body composition has greatly shifted in structure and overall composition (Popkin, 1998).

Finkelstein, Ruhm and Kosa (2005) state that it is important to identify economic factors that changed around the time of the increase in obesity prevalence. Rising national income is an important element that contributes to nutrition transition. Malnutrition is always one of the major health problems threatening the developing world. In the past, tremendous economic pressure in developing countries was the indicator of large underweight population due to food shortages. In recent years, large countries, such as Brazil and China, have benefited from improved economic and social conditions, and the rates of obesity have increased dramatically (Wang, Monteiro, & Popkin, 2002). A national nutrition survey in China estimated that between 1992 and 2002, there was a 22.8% increase in the overweight population to over 200 million people (Rigby, 2006).

*The Prevalence of Obesity in China*

China has experienced an extraordinary economic and social transition, along with an ever-increasing obesity rate due to a radical transformation of people's lifestyles, dietary habits, and health-related behaviors, since the last decade of the 20$^{th}$ century (Popkin, 2001; Popkin & Gordon-Larsen, 2004; Du, et al., 2002; Ma, et al., 2005; Wang, et al., 2007). The rapid increase of the obesity rate in China is of great concern. For example, a past study shows a substantial increase in overweight and obesity rate for Chinese adults in all gender and geographic areas, from 14.6% to 21.8%, over the 10 year period from 1992-2002 (Wang, et al., 2007); this increasing rate is similar to what the United States experienced in 40 years from 1960-2000 (Flegal, et al., 2002). Most recent data shows a sharper raise from previous studies; 45% of male and 32% of female adults were categorized as overweight or obese in 2010 (Patterson, 2011); this implies that approximately one-fifth of the world's one billion overweight or obesity people are Chinese (Wu, 2006).

### *Economic Costs of Obesity*

Past studies have prompted a surge of research efforts attempting to capture the economic costs of obesity (Roux & Donaldson, 2004). Recent estimates suggest that obesity is increasingly prevalent in most developed countries. In developed countries, 2% to 7% of total health care costs are attributed to obesity and its negative health consequences (Allison, Zannolli, & Narayan, 1999; WHO, 2000). Current studies show that the aggregate annual obesity-attributable medical costs in the U. S. are between 5 to 7 percent of annual health care expenditure (Finkelstein, et al., 2005). In Canada, the total direct cost of obesity was estimated to be over $1.8 billion in 1997, which corresponded to 2.4% of the total health care expenditure for all diseases (Birmingham, et al., 1999).

The increasing overweight and obesity rate in China has also placed a heavy economic burden on the country; for instance, scholars estimate that as much as one-quarter of the direct costs of four major chronic diseases in China may be due to overweight and obesity; that is approximately 3.7% of total national medical costs (Zhao, et al, 2008). China's experience suggests that there is an urgent need for understanding the underlying mechanism by which social determinants may contribute to the rapidly growing obesity gradient.

### *The Dissertation Outline*

In this dissertation, I pay special attention to the causal connections between SES and obesity as well as the reciprocal relationship. I use concepts such as the effects of social and cultural norms, individual and population health over the life-course, and social conditions as fundamental causes of obesity disparities. The dissertation is organized as follows; Chapter 2 provides background literature review and develops a series of hypotheses for three studies including, "study 1: the effect of household technology on obesity and body mass index", "study 2: obesity pay gap: gender, body size, and wage inequalities", and "study 3: socioeconomic status, social mobility, and body weight". The dissertation addresses the following questions: Does recent rapid mechanization in China affect obesity? Specifically, does increasing household technology adoption at home affect the risk of obesity, and how does gender division in household labor play a role in affecting body weight differentials for men and women? In addition, does Western body image adoption evoke discrimination in the workplace, and are the same obesity wage penalties that can currently be seen in the U.S., such as wage reductions for obese individuals, also observable in changing China? Do recent changes to occupational structure, increasing interpersonal relationships in the workplace, underline the obesity wage disparities?  Finally, is the SES-obesity association in China similar to that found in developed countries? Does a social inequality exacerbate the risk of obesity for people who were stuck in the lowest section of the SES ladders throughout their lifetime? Does social mobility play a role in reversing the risk of obesity for disadvantaged populations?

Chapter 3 describes the study population and each study's analytic sample, variables and statistical method. Chapter 4 states rapid technological changes that have the potential to lead to obesity epidemics. This study provides evidence that household technology ownership and weight gain are linked, while changes in overall energy intake and exercise may not function as mediators for this relationship. Chapter 5 argues that female obesity is not subject to wage penalties, while current male obesity rates may be worsened due to heightened economic outcomes and greater social acceptance by customers and colleagues. Chapter 6 discusses the results of the impact of social mobility on the risk of obesity. The study shows that women who had a higher educational category than their fathers or mothers (or women who experienced upward social mobility) had smaller body size compared to those whose SES remained the same. This implies that women who have chance to advance themselves to higher SES ladders compared to their fathers' are less likely to be obese than women who remained with their father's SES category. Finally, Chapter 7 summarizes the findings and draws conclusions and implications for each study.

# CHAPTER 2

## BACKGROUND LITERATURE AND HYPOTHESES

China has been undergoing economic, social, and political transition, from the Communist Revolution in the late 1940s, the Great Leap forward and Famine in 1950s, the Cultural Revolution during 1960s-1970s, to the introduction of the post-Mao economic reforms, 1978 to present. China's experience provides an unusual opportunity for a meaningful public health conversation to discuss rising levels of obesity as the result of capitalism, modernization, and industrialization. The effect of household technology on obesity, the wage inequalities by body size, and the effect of social mobility on obesity are three of the major problems and challenges that China currently faces.

This chapter consists of three parts: In study 1 "The effect of household technology on body mass index among Chinese adults," I discuss and review the literature about household technology, such as air conditioners, washing machines, and food preparation devices, launched in China during the past two decades and their potential to cause weight gain or obesity. I contrast China's recent modernization and machination to what Western societies have experienced in pasts decades; I also argue that gender differences apply in household technological practice. I develop these arguments based on traditional gender division in household labor, and how diverse household technological usage may impact the risk of obesity differently by gender.

In the second part of this chapter, I present and review the important literature linked to Study 2, "The obesity pay gap: gender, body size, and wage inequalities." Past western studies show that gaining weight or becoming obese is negatively associated with economic well-being for women, while there is mixed evidence for the association between weight status and economic outcomes among men. Whether this phenomenon has emerged in China is still unknown. In this study, I discuss recent China's interpersonal relationships in the workplace, which have been growing as the results of urbanization, capitalization, and service-based employment. The rise of interpersonal relationships in the workplace may promote the emergence of social bias, prejudice, and discrimination associated with body size by gender in today's rapidly developing world, and this may have triggered wage disparities by body size.

Finally, in Study 3 "Obesity, life course socioeconomic status and social mobility," I argue that China's economic reforms have brought remarkable social and economic development; while socio-economic inequalities have also widened ever since. In this chapter, I focus on the literature related to the topics in this third study of the dissertation, one that focuses on investigating intergenerational social mobility and the risk of obesity based on the Chinese social inequality context. My frameworks are based on theories of fundamental causes of diseases, life courses approaches of socioeconomic status and the risks of obesity, and past studies in social mobility.

*Study 1: The Effect of Household Technology on Body Mass Index among Chinese Adults*

*Household Technological Development and Obesity*

Finkelstein, Ruhm, and Kosa (2005) argue that technological improvement is one of the primary causes of the increased obesity after the 1980's. Developing technology allows people to rearrange their schedule, which affects dietary habits, activities, and nutritional status. Past Western studies have drawn upon the relationship between a variety of modern technologies and obesity prevalence. For example, scholars argue that agricultural innovation has resulted in increasing food availability and reducing food prices; these factors encourage higher calorie consumption which has been found to be related to obesity (Cutler, Glaeser, & Shapiro, 2003; Lakdawalla & Philipson, 2009). Mechanization promotes sedentary forms of lifestyles; studies show that each additional hour spent in a car per day is associated with a 6% increase in the likelihood of obesity (Frank, Andersen, & Schmid, 2004). People who perform daily tasks with modern devices, including using washing machine, dishwasher, car, and elevator, spent 111 kcal less than completing those tasks manually, which potentially adds 10 lbs (4.5 kg) for a person yearly (Lanningham-Foster, Nysse, & Levine, 2003). On the other hand, studies examining the association between household technology adoption and the potential risk of obesity have been limited to Western populations; the direct evidence for this association is still inconclusive in recent developing countries, where the initial adoption and spread of household technology has occurred much more recently. For example, Television (TV) was initially adopted by Chinese households in the 1980s, increased significantly in the 1990s, and universalized after 2002-2008 (Italian Trade Commission 2011); this is about 30 years behind the U.S. where TV implementation in homes started in the late 1940s and has been be extensively spread since 1975 (World Bank, 2014; Bowden & Offer, 1994).

*The Growth of Obesity and Household Technological Development in China*

Recent empirical data collections in China provide an unprecedented opportunity to rigorously evaluate the association between household technology and obesity, and the extent to which it will be possible to extract meaningful information from the Chinese experience for recently developing countries. In addition, the relationship between the adoption of household technology and obesity is likely to be different in rapidly developing countries than in settings that already completed the "household technology transition", as in Western societies. Chinese household technology launched during past two decades seems to have the potential to transform lifestyles in major ways. For example, recent patterns in China show a large rise in average viewing hours consistent with the initial spread of television. In contrast to the spread of television viewing in America in the 1950s; however, China's widespread adoption of TV is accompanied by large TVs connected to DVD players and videogames. Thus the TV that has recently spread through China today is potentially more immersive, engaging, and more likely to draw viewers into sedentary behavior. For example, between 1997 and 2004, the average time spent on watching TV among teens and children increased from 2.78 to 3.12 hours in the U.S. and from 0.95 to 1.61 hours in China; that is a 11.85% and 68.95% increase respectively (Television Bureau of Advertising, 2010; Zhang, et al., 2012).

A weakness of many existing studies on household ownership of domestic technology and Chinese obesity, is that they do not adequately capture the dynamic processes of adopting household technology on weight change (Bell, Ge, & Popkin, 2002), nor do they control all the time-invariant confounders, such as unmeasured individual predispositions, which makes it difficult to infer any firm causal judgments (Bell, et al., 2002; Monda, et al., 2008; Qin, Stolk, & Corpeleijn, 2012; Lear, et al., 2014). Specifically, our study focuses on a particular direction of causation, that ownership of household technology affects BMI change and not the reverse. Finally, past research studies in China did not emphasize gender differences with respect to the association of household technology adoption and the risk of obesity (Bell, et al., 2002; Lear, et al., 2014). Our study emphasizes the gender differences in the use of household technology.

*Division of Household Labor and Household Technology*

Labor-saving devices and food preparation technologies are used to reduce time spent on domestic chores and arduous household tasks primarily carried out by women; for example, rapid economic and social development has altered the value of time for women; on the other hand, food preparation technology, such as microwaves, refrigerators, rice makers, or pressure cookers has made cooking at home possible by speeding up the shopping, preparing and cooking process; however, scholars argue that introducing labor-saving devices or food preparation technologies does not reduce women's time in housework; instead, it only changes the way that women perform household tasks (Shehan & Moras, 2006). As an example, Shehan and Moras (2006) review the history of laundry in the U.S. They argue that after washing machines were widely used in homes, housewives took over the responsibilities for these tasks that had previously been performed in the household by hiring paid laundresses and spent more time themselves on laundry. Robinson (1985) also observes that in order to rejuvenate China's economy, Deng Xiaoping promoted the availability of modern household technology with the intention of liberating women from arduous housework to free them for participation in labor production; however, modern household technology continues to tie women to traditional gender roles. Modern Chinese women still perform most private duties and domestic based work in the home (Robinson, 1985). In short, whether labor-saving devices and food preparation technologies "save" women's energy expenditures in household works is still unclear.

Other household technologies are also utilized differently by gender. For example, Sugiyama et al. (2008) found that women spent less time on video watching, computer use, listening to music, talking on the phone, and driving in a car. The report from the Television Bureau of Advertising shows that American women spent more time viewing television compared to men, teens and children during 1988-2009 (Television Bureau of Advertising, 2010). In short, gender differences are likely to persist in other settings, including China. In order to understand how obesity is affected by household technology adoption, it is important to take gender differences into account.

*The Mediator between Household Technology Adoption and Weight Gain*

There are two main hypotheses to explain the adoption of household technology–BMI increases link: the first hypothesis is that exercise and total dietary calorie intake may function as mediators to the extent that they account for the relation between owning household technology and BMI increases. That is, household technology may cut leisure time spent exercising and increase daily calorie consumption, thereby triggering BMI increases. For instance, Jakes et al. (2003) discovered that for both men and women, increased television viewing greatly decreased participation rates in vigorous activities. Furthermore, TV viewing is positively associated with caloric intake and calories from fat; people snack more when they are in front of the TV (French, Story, & Jeffery, 2001; Jeffery & French, 1998). Kobayashi and Kobayashi (2006) observed that the invention of air conditioners brought lifestyle changes to Japan; they suggest that during the hot summer season, children now spend significantly more time indoors playing video games, watching TV, or studying rather than taking part in outdoor activities. However, this hypothesis still lacks direct supporting evidence.

An alternative hypothesis is that adopting household technology is a factor independent of exercising and daily calorie consumption for BMI increases. Evidence has shown that applying labor-saving devices has resulted in less energy expenditure for women (Lanningham-Foster, et al., 2003). Substituting TV viewing with walking around at home is sufficient to expend energy equal to a 6.61 lb (3 kg) weight loss during a year among adults (Buchowski & Sun, 1996). Numerous scholars have found the relationship between TV viewing or computer use and obesity remains salient even after controlling for exercising and overall food intake (Coakley, et al., 1998; Hu, et al., 2003; Koh-Banerjee, et al., 2003; Vandelanotte, et al., 2009). In other words, a decline in low-intensity activities may be the reason adopting household technology increases the risk of obesity. This decline in low-intensity activities, such as daily chores around the home and hand washing clothes, is relatively independent of discretionary activities that might account for the BMI increases. For example, food-preparation technology, such as refrigerators, may reduce daily energy used shopping in grocery stories. Communication devices including telephones and cell phones may decrease traveling and physical social interactions, such as walking door to door to visit relatives and neighbors. Entertainment devices including TV, DVD/VCD players, and computers can encourage watching sports, movies, and concerts at home rather commuting to stadiums, theaters, and concert halls.

The empirical evidence shows that the daily calorie consumption has declined while energy expenditure in exercise has increased; with a rising prevalence of obesity in the past two decades in China (Du, et al., 2002; Ng & Popkin, 2012; Ng, Norton, & Popkin, 2009). To explain these diverging trends, our hypotheses include,

*Hypotheses*

*Hypothesis 2.1-1:* Adopting household technology will be associated with weight gain.

*Hypothesis 2.1-2:* Adopting household technology is a factor independent of exercising and daily calorie consumption for weight gain; in other words, daily calorie consumption and energy expenditure in exercise will not function as the mediator to the association of household technology adoption and weight gain.

*Hypothesis 2.1-3:* Since household products are utilized differently by gender; there will be gender differences in the relationship between obesity and a variety of household technologies.

*Study 2: Obesity Pay Gap: Gender, Body Size, and Wage Inequalities*

*Cultural Perspectives on Body Size*

Throughout history, a large body size was valued, and fatness was viewed as wealth and power (Cassidy, 1991). The growing economy and emerging leisure class in the early twentieth century has shifted the public value of fatness as beauty to thinness in Westernized countries (Cogan, et al., 1996). Desire for skinniness is a relatively new phenomenon (Cassidy, 1991). Becker (2004) identifies that the global distribution of Westernization and consumer culture constructs the female concept of body image. She found that not only women in developed countries draw heavily on thinness as self-identity but also women in developing countries look at thinness as beauty. The symbol of thinness has led to social hazards such as poor body image, eating disorders, and massive body plasticity (Gordon, 2000; Becker, 2004). Orbach (2006) believes that behind the so-called obesity epidemic is a serious public emergency and fashion, cosmetic and media industry conspiracies.

In traditional Chinese cultural perspectives, female plumpness was a symbol of fertility and beauty; excess body fat is widely seen as a symbol of health and prosperity (Wu, 2006); however, accelerated urbanization, along with explosive capitalism and Western-dominated fashion ideas (Hartley & Montgomery, 2009; Segre Reinach, 2005), have led to thin and skinny becoming one of the new identities in China (Chen, Gao, & Jackson, 2007; Leung, Lam, & Sze, 2001; Luo, Parish, & Laumann, 2005; Xu, et al., 2010). Gottschang (2001) observed that Chinese modernization reshaped norms for the female body, even among pregnant or postpartum women. With the rise of energy-dense, sugar-rich, high fat diets and sedentary lifestyles (Astrup, et al., 2008; Bell, et al, 2002;

Ng, et al, 2009), it is even more difficult for women to maintain an ideal body size. The ever-increasing pressure felt by women to attain the ideal body has led to an emergence in eating disorders in Chinese society (Chen & Jackson, 2008; Huon, et al., 2002; Lee & Lee, 2000; Tong, et al., 2012).

On the other hand, little research has been conducted on Chinese men's body identities. Chinese men are less preoccupied with body image compared to Western men (Yang, Gray, & Pope, 2005), and body dissatisfaction was not related to Chinese men's self-esteem or depression (Davis & Katzman, 1997). It is worth noting that weight gain has positive connotations for men in both Chinese and Western societies. For example, corpulence is considered a symbol of status and wealth in Chinese men; Western culture also believes that larger body size is related to the perceptions of dominance and virility (Cassidy, 1991). Studies show acculturation to Western society may even increase the male desire for larger body size. For example, scholars found that resident Chinese men display more concerns about their body type and are more likely to prefer their bodies at a heavier weight compared to Caucasians in the United State (Yates, Edman, & Aruguete, 2004).

*Body Size and Wage Inequalities*

Past studies on the obesity wage penalty in labor markets are primarily focused on how body type discrepancy by gender generates discriminatory economic outcomes, based on the assumptions of employment-based discrimination, schooling, and marriage market processes. For example, studies suggest a negative association between body size and economic well-being in women (Baum & Ford, 2004; Cawley, 2004; Conely & Glauber, 2007; Glass, Haas & Reither, 2010). While some studies show there is an obesity wage penalty in men (Baum & Ford, 2004; Kline & Tobias, 2008), others state that the association does not exist (Averett & Korenman, 1996). Scholars suggest that body type-wage differential may result from bias, prejudice, and distaste toward unattractive workers where more social interactions are present (Han, Norton, & Stearns, 2009).

China has undergone the shift from a centrally-planned to a market based economy after reforms in the late 1970s. The number of tenured employees working in labor intensive and permanent occupations provided by state-run and collective-owned enterprises declined noticeably. This decline was accompanied by increasing non-manual employee work in privately owned industries. In other words, the economic expansion in China has brought major changes to occupational structure; as a result, interpersonal relationships with customers or colleagues have been increasing in the workplace. Past research investigations into the economic consequences of body weight are predominately focused on Western populations. Wage disparities among occupations may emerge due to increasing interpersonal relationships in the workplace where the body size discrimination or preference is present. It is important to learn from China's experience on how increasing obesity incidence impacts individual economic outcomes in the rapidly developing world.

*Hypotheses*

Based on previous discussions, I propose that the obesity wage penalty may emerge in modern China due to increasing social interactions in the workplace, where customer or colleague discrimination against body size is present. I hypothesize

*Hypothesis 2.2-1:* There will be a negative association between body size and wage for women but not for men

*Hypothesis 2.2-2:* For women, the impact of body size on wage will be stronger for the occupations requiring extensive interpersonal relationships in the workplace; on the other hand, the link between body size and wage outcomes will be weaker for the occupations requiring low social interactions in the workplace; for men, there will be no association between body size and wage regardless occupations.

*Study 3: Socioeconomic Status, Social Mobility, and Body Weight*

*The Theory of Fundamental Causes of Diseases*

SES is a term unadventurously used to refer to an individual's or a group's location in the structure of society, and determines disparity access to power, privilege, and advantageous resources. Socioeconomic status is typically assessed by education, income or occupational status (Schulz & Mullings, 2006). Across societies with and without universal health care, the association between higher SES and better health is one of the most consistent findings in medical sociology (Smaje, 2000). The great socioeconomic disparities between racial/ethnic populations are a dominant explanation for health differentials between racial/ethnic groups. Rogers (1992) finds that adjusting racial disparities in health for SES substantially reduces some measures of differences in mortality between blacks and whites. In some cases the race disparity even disappears altogether when adjusted for SES. The Rogers (1992) study shows that SES may be the primary underlying cause of the differences in health.

A review of international published studies on the relationship between SES and obesity conducted by Sobal and Stuckard (1989) between the 1930's and the late 1980's found that obesity in developed countries was more prevalent among people of lower SES than among those of upper SES. In developing countries, the opposite is true; a strong direct relationship exists between high SES and obesity.

Hossain, Kawar and El Nahas (2007) also indicate that being poor in one of the poorest countries is associated with being underweight and malnourished, while being rich has the highest risk for obesity in these countries. Conversely, being poor in a middle-income country is associated with an increased risk of obesity. However, the pattern of social disparities in obesity is more consistent among women than among men. For example, obesity is six times more prevalent among women of lower SES than those of upper SES in most developed countries (Sobal & Stuckard, 1989).

The fundamental cause approach explains health disparities based on socio-economic processes that influence unequal access to resources through material and social goods. Link and Phelan (1995/2002) “fundamental social causes” approach argues that “individuals who control more resources of knowledge, money, power, prestige and social connections keep on achieving superior health, and the gap of economic and social factors in population health will continue to be persistent.” Link and Phelan (1995) consider social conditions to be the fundamental causes of diseases, because social factors embody access to important resources to avoid health risks and affects compound health outcomes through these mechanisms.

The theory of fundamental causes of disease offers an understanding of the reproduction of social gradients in health under health transitions (Phelan, et al., 2004). When health related situations change, individuals who command social resources are able to transport themselves to a better position to take advantage of new knowledge about health risks and protective factors (Phelan, et al., 2004). In other words, when a country is relatively better off, people with higher SES are more capable of avoiding the risks of obesity by avoiding risk factors or adopting currently available protective strategies, such as quitting smoking, eating a healthy diet, and exercising. Therefore, among developing countries, there are positive associations between obesity and SES (Sobal & Stunkard, 1989; Kim, et al., 2004; McLaren, 2007), but when the transition of socioeconomic and health conditions are well underway, the inverse association between SES and obesity starts to emerge (Monteiro, et al., 2004; McLaren, 2007).

*Life Course Approach and Social Mobility*

The life course approach offers a comprehensive model for better understanding the development of disease and the promotion of obesity. The life course approach reaffirms that the relative importance of influences at different stages varies for the cause of obesity and serves as a framework to understand the influence of socioeconomic factors on obesity over a lifetime.

Scholars argue that past studies with data on SES at only one stage of life were inadequate for fully elucidating the contribution of socioeconomic factors to obesity. For example, researchers found there are a lasting effect of childhood SES on weight status, and the impact of childhood SES on obesity is as strong as the individual's current SES (Goldblatt, Moore, & Stunkard, 1965; Ball & Mishra, 2006). In short, when investigating the association of social conditions and the risk of obesity, scholars must include a broader range of SES to fully understand the mechanism of body weight differentials.

Social mobility means the difference between an individual's current SES and that of the family that raised him/her (Beller & Hout, 2006). Although past studies show that deprivation in childhood is a strong predictor for adulthood obesity, upward intergenerational social mobility can reverse the effect of early life disadvantage for women, and those who experienced downward social mobility may have a greater risk of obesity compared with those whose childhood and adult SES remained the same (Blane, et al., 1996; Braddon, et al., 1986; Goldblatt, et al., 1965). While rising social inequality does not necessarily increase or decrease intergenerational social mobility, great social inequality may create diverse meanings for social immobility groups; the health benefits of individuals staying on the top SES may be larger, while the health consequence for people who are stuck on the bottom SES are much more serious, compared to the rest of the social immobility group.

After 1978, China applied economic reforms directed by Chinese leader Xiaoping, Deng and moved toward a more market-oriented mixed economy under one-party rule. During this period, China began to enjoy extraordinary economic growth with 9.5% growth rate each year since the 1990s, reaching an all-time high of 14.2 % by the end of 1992 (Trading Economic, 2012). Although China's economic reforms at the end of the 1970s have brought remarkable social and economic development (Holz, 2008; Tang, et al. 2008), socio-economic inequalities have been also widening ever since (Luo & Zhu, 2008; Chen, 2010). For example, the Gini coefficient increased by 50 % during 1978-2004, from .3 to .45 (Luo & Zhu, 2008); and this fast inequality gain was largely due to rapid economic growth and slow poverty reduction in China (Ravallion & Chen, 2004). In other words, despite the general raising of SES level in the Chinese population, most people today have less opportunity to advance themselves to the top circle of the society compared to the period prior to the reform period.

Previous studies have some limitations, in that they exclude the important information of "socially immobile" groups (Blane, et al., 1996; Braddon, et al., 1986; Goldblatt, et al., 1965). People who experience social immobility could be those who are stuck in the bottom, or those that stay on the ceiling. Being raised in a low SES family and remaining in the same social class in adulthood could have very different health outcomes compared to those who are raised from higher social class families and remain the same in adulthood.  Past studies did not separate these two social groups, and put them into the same category of “socially immobile” (Blane, et al., 1996; Braddon, et al., 1986; Goldblatt, et al., 1965). Ignoring the differences between these groups overlooks the fact that people stuck in the bottom may have the most serious risk of obesity and related illnesses, rather than those who experience downward mobility. Previous studies also neglect the fact that people who are “immobile" at highest SES (ceiling) may have the most ideal body weight and health compared to those who experienced upwardly mobility.

Based on previous discussions, I propose that due to the rapid socioeconomic transition in China, social disparities in obesity may be produced within a short period of time. However, recent China’s increasing social inequality suggests that those individuals who are trapped on the bottom ladder of SES may have the highest risk of obesity compared to those who experience downward mobility. In contrast, people who dwell in the top SES may enjoy the most ideal body weight compared to those who experienced upwardly mobility. In this study, I investigate whether social mobility is the key mechanism in determining body weight disparities; the hypotheses are presented as below:

*Hypotheses*

*Hypothesis 2.3-1*: People who stayed in the bottom of SES have highest risk of obesity compared to the rest of the sample who experienced upward mobility, immobility, and downward social mobility (including people who moved down to the lowest SES)

*Hypothesis 2.3-2*: People who stayed in the top of SES have the most advantage compared to those whom experienced downward social mobility, immobility, and upward social mobility (including who moved up to the highest SES)

*Hypothesis 2.3-3*:  Past studies show that social mobility is more predictive for women's body weight; therefore, there will be gender differences in the relationship between social mobility and weight status.

# CHAPTER 3

# METHODOLOGY

In this chapter, I first introduce the data used for the three studies in this dissertation. Then I discuss the characteristics of each analytic sample and describe the definitions and measurements of the variables and methods in each analysis. The characteristics of the analytic samples and measurements in each study are presented in Table 3-1.

## *Data*

The China Health and Nutrition Survey (CHNS) is an ongoing longitudinal project that gathers data on health, nutrition, and socioeconomic indicators at the individual, household, and community levels. The survey began in China in 1989 with follow-ups in 1991, 1993, 1997, 2000, 2004, 2006, and 2009. The first round of data collection was undertaken in 1989 using a multistage, random cluster process to draw a sample from 8 provinces (Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong), which vary substantially in geography, stage of economic development, public resources, and health indicators. Counties in each province were stratified by income levels, and multistage random sampling was used to select four counties in each province based on per-capita income reported by the National Bureau of Statistics. Within each county or urban area, neighborhoods were randomly selected from urban and suburban, townships, and villages. Twenty randomly selected households were chosen within each neighborhood. The provincial capital and a lower income city were selected when feasible. Villages and townships within the counties and urban and suburban neighborhoods within the cities were selected randomly with a total of 190 primary sampling units in 1989-1993, and a new province (Heilongjiang) and its sampling units were added in 1997, while Liaoning Province was unable to participate in the survey for natural disaster, political and administrative reasons (Popkin, et al., 2010). In 2000, the Liaoning returned to the survey and 9 provinces including Heilongjiang continued to participate in all subsequent surveys (Popkin, et al., 2010).

There were 4,020 households surveyed in the 1989 wave with a total of 15,927 individuals from 8 provinces, and all individuals within a household were interviewed. Follow-up levels were high, but families that migrated from one community to a new one were not followed. Response rates were ~88% at the individual level and ~90% at the household level for participants of the previous year (Popkin, et al., 2010). CHNS data are not nationally representative, as provinces vary substantially in geography, stage of economic development, public resources, and health status. However, previous research findings on key physical composition and dietary data trends based on CHNS are similar to those revealed by nationally representative data (Ge, et al., 1994; Wang, et al., 2006) The CHNS is panel data that contains observations over multiple time periods; our models are able to incorporate all available measurements from each individual, which maximizes our analytic sample.

### *Analytic Samples*

For this research, I focused on data where respondents, age 18-55, completed weight and height examinations by health care experts during 1997-2009. The 1989–1993 survey is omitted due to lacking information for energy expenditure in exercise before 1997.

Only individuals observed over multiple time periods during 1997-2009 are included (85.27 %, 37,592 cases). Among the 37,592 cases, women who were pregnant or breastfeeding (1.50 %; 563 cases) are omitted. “Transportation activity” contained one-fourth missing values in our subsample. I investigate the patterns of missing values of transportation activity and found that 79.77 % of individuals were not current working or going to school; I believe those data are missing because transportation activity is not relevant for individuals who do not commute to work/school. Therefore, I recoded missing values to 0 METs hours per week. “Home activity” contains 10.83 % missing values, and 83.63% of those missing were from males. I believe these data are missing because home activity is not relevant to individuals who do not perform domestic work tasks; therefore, missing values are recoded as 0 METs hours per week. Finally, only 73.29 % (27,140 cases) of the records, 13,037 males and 14,103 females from 12,285 households, which have information of age, marital status, socioeconomic status, smoking status, and physical activities in exercise, occupation, transportation, and home are included in our final analysis.

In Study 2, height and weight measurement were also obtained by health care experts during 1991-2009, and only the subsample 44,408 (74.28 %) person-year with complete weight and height is included. In addition, only individuals who were employed during any given survey year are included. Among the 36,177 employed individuals, only the 13,955 (38.57 %) who listed wage information are included. In addition, the .55 % of women who were pregnant and .57 % of women who were breastfeeding during any given survey are also omitted. Finally, only 12,159 (88.11%) of individuals have information of age, years of education, health constraints, marital status, occupations, and average hours a day are left in the subsample I analyze. My final subsample includes 6,944 males and 5,132 females observed in CNHS survey waves 1991, 1993, 1997, 2000, 2004, 2006 and 2009 between the ages 18-55.

In Study 3, I focused on data where respondents age 18-55, completed the weight and height examinations (44,408; 74.28%), and who were the son or daughter of their household in any (or all) years between 1991 and 2009. The sons or daughters are linked to their household head. Only 7,277 of individuals have information of age, education, household head's education, current household gross income, marital status, occupations, province, and residential area. Women who were pregnant or breastfeeding during any given survey year were omitted. Among selected 7.277 individuals, most respondents had a father as household head in the sample (67.28 %), 19.57% of respondents had a mother as household head but not a father, and 13.15 % of respondents have either a father or a mother as household head (unknown). The final longitudinal data subsample includes 4,897 males and 2,380 females from 2,677 households.

*Study 1: The Effect of Household Technology on Body Mass Index among Chinese Adults*

*Measurements*

Dependent variable: BMI

Body mass index (BMI) is defined as $\frac{Weight\ (kg)}{Height(m^2)}$ in its continuous form. According to Centers for Disease Control and Prevention (CDC, 2012) growth charts, by calculating weight in kilograms divided by height (in meters) squared, underweight is at or below the 5$^{th}$ percentile; healthy weights are between the 5$^{th}$ and 85$^{th}$ percentiles, those at risk for being overweight are between the 85$^{th}$ and 95$^{th}$ percentiles, and the overweight are at or above the 95$^{th}$ percentile. Obese is defined as the top 15$^{th}$ percentile (Ogden, et al., 2006). In Caucasian populations, BMI is divided into standard categories for underweight (BMI<18.5), normal weight (18.5≤ BMI< 25), overweight (25≤ BMI<30) and obese (BMI ≥ 30).

James, et al. (2012) examine the worldwide obesity epidemic and found that Asian investigators have supported an alternative classification system, because the absolute levels of diabetes and hypertension on the age- and sex-specific basis is higher in people of Asian origin. This implies that in adult life, increases in BMI, may have a different impact in different societies. Therefore, in this dissertation, I use the World Health Organization (WHO)-Asian criteria when referring underweight (18.5< BMI), normal weight (18.5≤ BMI< 23), overweight (23 ≤ BMI< 25) and obesity (BMI ≥ 25).

Independent variables: Household Technologies

At each survey wave from 1997-2009, the CHNS collected information regarding household ownership of electrical appliances and equipment via the following questions:

“Does your household own this appliance (yes/no)?” and “Does your household own this type of transportation (yes/no)?”

In this study, I examined the relationship between mean BMI and seven types of household technologies. I supposed that individuals who live in households that have the greatest ability to adopt all kinds of technologies would have the most significant weight change. Six technological devices in our regression models were recorded as a categorical variable: 1 represents owning the appliance and “0” represents that the household did not own any such appliances. Household technologies were categorized based on the type of function and the patterns in the primary regression models: (1) televisions; (2) computers; (3) washing machines; (4) two communication devices (telephones and cell phones); (5) air conditioners; and (6) motorized vehicles (cars and motorcycles). (7) Four food-preparation technologies (refrigerators, microwave ovens, electric rice makers, and pressure cookers) were recorded as a continuous variable; numbers represent number of appliances owned, and “0” represents that the household did not own any such appliances. Note that CHNS collected the household ownership of cell phones only after 2004.

Covariates/control variables

Studies have found that marital status and age are factors influencing body weight (Gallagher et al. 1996; Ogden et al. 2006). For example, BMI increase is a common occurrence as people get older and the most substantial BMI increases occurs during the middle age (Bennett et al. 2008). Previous studies also show BMI-for-age curves are nonlinear; studies suggest that age-squared term should be included in analysis (Flegal et al. 2010; Rzehak and Heinrich 2006). Smoking can impact bodyweight; BMI of smokers is lower than non-smokers (Compton et al. 2006; Johansson and Sundquist 1999), but gaining substantial weight after quitting smoking is quite common (Schwid et al. 1992). Past studies show socioeconomic status (SES) and obesity have a strong relationship, especially among women (Sobal and Stunkard 1989; McLaren 2007). For example, Western literature documents that a lower educational attainment is often associated with a higher obesity rate, while developing countries present the opposite trend (Roskam et al. 2010).

Based on the discussion above, the time-varying covariates that I have controlled in this study include: (1) Current age and age squared. (2) Marital status: recoded as a binary variable, currently married, and currently not married (included single, divorced, widowed, or separated). (3) Smoking status: recoded as a binary variable, currently smokes versus currently does not smoke and (4) socioeconomic status: there were two SES variables used in this study. “Education” was recoded as no education, primary education, secondary education, and college or above. “Household gross income” was built by adding each household’s nine potential sources of income: business, farming, fishing, gardening, livestock, non-retirement wages, retirement income, subsidies, and other income. When any component was incomplete, an attempt was made to impute the missing data. Details of the imputation have been described in China Health and Nutrition Survey - Carolina Population Center. For interpretability, household gross income was logged. In such models, the logged case refers to the proportional change in the household gross income for one BMI increase. Finally, I also controlled for (5) Survey year: 1997, 2000, 2004, 2006, and 2009 in all regression models.

Mediating Variables: Caloric Intake and Energy Expenditure

Arithmetically, an individual gains weight through a positive energy balance; that is, when calories that an individual consumes exceeds calories that he or she expends. It is essential to consider changes in dietary consumption and energy expenditure in exercise as key components in weight change between 1997 and 2009 in China. In our study, “daily calorie intake” refers to the energy value of all food consumed within 24 hours, averaged over 3 days, and calculated using the 1991 Chinese Food Composition Table (FCT) for year 1997 and 2000 only; the 2002/2004 FCT was used in all following years. Detailed descriptions of the dietary survey are presented in China Health and Nutrition Survey - Carolina Population Center. I also controlled the change of calories in daily fat, carbohydrate, and protein intake, but it was not found to significantly alter the estimates and was excluded in the final models. “Exercise” was recoded as a continuous variable summed up by metabolic equivalent (METs) hours per week of participation in activities including: martial arts, jogging, swimming, dancing, aerobics, sports, and others. Other energy expenditure in non-exercise physical activities controlled in our models includes occupational activity, transportation activity, and home activity. “Occupational activity” is categorized as very light/light (office worker, watch repairer, salesperson, laboratory, etc), moderate (student, driver, electrician, metal worker, etc.), and heavy/very heavy (farmer, dancer, steel worker, athlete, loader, logger, miner, stonecutter, etc.). The total weekly energy expenditure is estimated by METs hours per week of participation in occupational activities. “Transportation activity” is based on whether or not the participants walked or biked to school/work and was summed up by METs hours per week for biking or walking. Home activity” is based on whether or not the participants reported time spent in preparing food, buying food, doing laundry, and in childcare. The total weekly energy expenditure is estimated by time spent in each home activity, multiplied by specific MET values based on the Compendium of Physical Activities. Detailed descriptions of the measurements of metabolic equivalent for physical activities in exercise, occupation, transportation and home are presented elsewhere (Ainsworth et al. 2000; Ng et al. 2009).).

*Statistical Analyses*

I selected fixed-effect (FE) regression models because they have two attractive features: First, FE models are efficient in estimating the effect of variables that vary considerably *within* an individual. Second, FE models are designed to study the causes of changes within an individual by controlling for potential unobserved heterogeneity bias, so that I could generalize my results to all individuals who were selected. In other words, standard regression models are more likely to suffer from omitted variable bias and spuriousness because unmeasured factors are likely to be correlated with both the dependent variable and key independent predictors. FE models offer strong causal evidence because unmeasured factors that do not change within individuals over time cannot bias the relationship between the outcome and predictor variables (Allison, 2009; Baltagi, 2001; Wooldridge, 2002). Specifically, the linear regression model with time-invariant covariates in my study is written as:

$$y(BMI)_{it} = \alpha_t + \sum_{k=1}^{K} \beta_k \, x_{kit} + \sum_{m=1}^{M} \gamma_m \, z_m + u_i + \varepsilon_{it},$$

Where $\alpha_t$ is an intercept that may be different for each survey year; $\beta$ and $\gamma$ are vectors of coefficients. $x$ are time-varying covariates, including one of my independent variables and was recorded as a continuous variable: Numbers greater than 0 represent the household owned the number of appliances, and 0 represents the household did not own the appliance. It also includes covariates that I have controlled in my study, such as survey year, age, age square, marital status, smoking, and SES, as well as important mediators such as, daily energy intake, exercise, occupational activity, and transportation activity. $Z$ are time-invariant covariates, including year-specific and person-specific effects that play a role in weight gain. Covariates with “person-specific effects” are those that affect individuals in different ways but are constant across time, such as ethnicity, birthplace, childhood SES, and genetic factors. Covariates with “year-specific effects” are those that affect all individuals in the same way but change over time, such as food policy, obesity legislation, and so on.

There are two error terms in this model: $\varepsilon_{it}$ represents random variation of each individual at each survey year, and $u_i$ represents the effect of all unobserved variables on BMI that vary across individuals but are constant over time (Allison, 2009).

When estimating first-difference equations, the factors that are constant over time such as, $\sum_{m=1}^{M} r_m \; z_m$ and $u_i$ are removed from the equation, so FE does not allow us to assess time-invariant covariates (Allison 2009; Baltagi 2001; Wooldridge 2002). The final equation is written as:

$$\Delta BMI_{it} = \Delta\alpha + \sum_{k=1}^{K} \beta_k \; (x_{1it} - x_{kit-1}) + \varepsilon_{it}$$

where $\Delta$ is the first-difference operator. This model is meant to test whether or not there is a net effect of household technology on weight gain. Specifically, I am assuming a particular direction of causation, that ownership of household technology affects BMI change and not the reverse. The CHNS is panel data that contains observations over multiple time periods, and FE models are able to incorporate all available measurements from each individual (level 1), which maximizes my analytic sample. In those models, the "cluster" refers to each individual when repeated measurements in each year are nested (level 2). My FE models also incorporate household level variables, including the ownership of each household technology and household socioeconomic status. Finally, researchers have indicated that household technology may have different impacts on men and women; I ran the models separately by gender. All FE models were run on Stata, Version 13 (Stata Corporation, College Station, TX, USA).

*Study 2: Obesity Pay Gap: Gender, Body Size, and Wage Inequalities*

*Measurements*

Dependent variable: Wage

Wage refers to non-retirement salaries earned by the person and is used in this study as the economic outcome variable. Wage comes from CHNS longitudinal files, which have all of the data for each individual at each wave. For interpretability, wage has been logged. In such models, the logged case refers to the proportional change in the wage for one coefficient increase.

Independent variables

Body mass index is defined as $\frac{Weight\ (kg)}{Height(m^2)}$ in its continuous form. Underweight is defined as BMI $<18.5$; normal weight is defined as $18.5 \leq$ BMI$<23$; overweight is defined as $23 \leq$ BMI $<25$, and obesity is defined as BMI $\geq 25$ according to World Health Organization's (WHO) - Pacific region criteria, due to the absolute levels of diabetes and hypertension on the age- and sex-specific basis being higher in people of Asian origin (James, et al., 2012).

In this study, I categorized occupations into three groups by type of interactions in the workplace. (1) Professional employees: individuals working in these occupations require a high level of interactions with colleagues or customers in the workplace; professional employees have a higher degree of professional knowledge and skills and are less likely to be replaced due to customer dissatisfaction.  Included in this category are senior professional workers (doctor, professor, lawyer, architect, and engineer); junior professional workers (midwife, nurse, teacher, editor, and photographer); administrator, executive, manager (working proprietor, government official, section chief, department or bureau director, administrative cadre, village leader); athlete, actor, and musician. (2) Service workers: individuals working in this occupation category also require high interaction with colleagues or customers in the workplace; however, compared to professional employees, this category requires a focus on customer satisfaction. Occupations in this category include, office staff (secretary, office helper); helper (housekeeper, cook, waiter, doorkeeper, hairdresser, counter salesperson, launderer, and child care worker); driver; army officer, police officer, ordinary soldier and policeman. (3) Manual laborers (reference group): these occupations require minimal interactions with colleagues or customers in the workplace; farmer, fisherman, hunter, non-skilled worker (ordinary laborer, logger) and skilled worker (foreman, group leader, craftsman) are grouped into this category.

I argue that manual laborers have the least interpersonal contact with colleagues or customers compared to the other two categories; therefore, their wages are least likely to be impacted by physical appearances. In addition, I predict that service workers are most likely to be impacted by their body size due to a less professional setting and ease of replacement compared to professional employees.

Covariates/control variables

Previous Western studies have suggested that weight gain is associated with negative health consequences (Must, et al., 1999; Renehan, et al., 2008; Shai, et al., 2006); such as, less productivity due to absenteeism, sick leave and injuries that limit performance in the workplace (Schmier, Jones, & Halpern, 2006; Schultz & Edington, 2007). My models include health constraints in order to understand whether health limitations have confounded the associations between weight status and wage outcomes.

The variable of health constraints are entered as a dichotomous variable based on whether the participant self-reported having been sick, injured, or suffered from a chronic or acute disease in the last four weeks.

Studies indicate that marital status and age are important predictors for wages. For example, married men have higher wages than their never married counterparts (Antonovics & Town, 2004). In addition, aging may be related to wage growth; employees tend to have more work experience when getting older in the company, which is positively related to wages. It is reasonable to believe that full-time employees make higher wages than those who work part-time or irregular hours; in addition, higher education usually leads to higher wages. In short, confounders are controlled in this study including, (1) current age entered as a continuous variable. (2) Marital status is recoded as a binary variable, currently married and currently not married (includes single, divorce, widow and separated). Married is coded as 1. (3) Working hours is measured as the average working hours per day in the past year and entered as a continuous variable from .01 to 17.75. (4) Education is measured as the total number of years of formal schooling completed and entered as a continuous variable from 0 to 18. Finally, all models have controlled survey year 1991- 2009 and entered it as a categorical variable.

*Statistical Analyses*

It is important to rule out sources of potential endogeneity when investigating the association between body mass and economic well-being. Several methods used to deal with potential endogeneity of body mass on economic outcomes have been discussed thoroughly (Baum & Ford, 2004; Cawley, 2004; Conley & Glauber, 2007). In this study, I utilize individual fixed-effect linear regression to remove unobserved time-invariant heterogeneity.

FE methods are designed to study the causes of changes within a unit (individual, household, country, etc.) by controlling for potential unobserved heterogeneity bias in order to generalize the results to all of the units in the analysis. In this study, I utilize fixed-effect linear regression models to draw a causal effect of body mass index on wage outcomes.

The CHNS is panel data which contains observations over multiple time periods, and FE regression models are able to incorporate all available measurements from each individual, which maximizes my analytic sample. In those models, the "cluster" refers to each individual when repeated measurements in each year are nested (level 2); in addition, all the individuals are followed within households in any given survey year; my regressions control for household fixed effects (level 3). Specifically, the linear regression model with time-invariant covariates in my study is written as:

$$\ln(Wage)_{it} = \alpha_t + \sum_{k=2}^{K} \beta_k \, x_{kit} + \sum_{m=1}^{M} \gamma_m \, z_m + u_i + \varepsilon_{it}$$

Where $\alpha_t$ is an intercept; $\beta$ and $\gamma$ are vectors of coefficients. $x$ represents time-varying covariates, including the independent variable: body mass index; moderator: occupations; and covariates: survey wave, age, marital status, educational years, health limitations, and working hours. $Z$ represents time-invariant covariates, including year-specific and person-specific effects that play a role in changing individual economic outcomes. Covariates with "person-specific effects" are those which affect individual wage in different ways but are constant across time, such as, childhood SES, intelligence, ethnicity, etc. Covariates with "year-specific effects" are those which affect all individual's wage in the same way but change over time, such as, income tax, federal policy, economic growth, etc. There are two error terms in this model, $\varepsilon_{it}$ represents the random variation of each individual at each wave, and $u_i$ represents the effect of all unobserved variables on economic outcomes that vary across individuals but are constant over time (Allison, 2009).

When estimating first-difference equations, the factors that are constant over time such as, $\sum_{m=1}^{M} r_m \; z_m$ and $u_i$ are removed from the equation, and the final equation is written as:

$$\ln(Wage_{it}) - \ln(Wage_{it-1}) = \Delta\alpha + \sum_{k=1}^{K}(\beta_k - \beta_{k-1})(x_{2it} - x_{kit-1}) + \Delta\varepsilon_{it}$$

Finally, I add interaction terms of BMI with occupational types to the equation; the occupational types are treated as a categorical variable in models with farmers/laborers as the reference group. All models were run separately by gender.

*Measurements*

Dependent variable: BMI

BMI is defined as $\frac{Weight\ (kg)}{Height(m^2)}$ in its continuous form; height and weight were measured by doctors, nurses, or other healthcare professionals in any given year of the survey.

Independent variables: Parental SES, Own SES, Social Mobility

(a) Parental & own SES

In this study, parental socioeconomic status refers to household head's education (primarily fathers), and own socioeconomic status refers to respondent's education. I have divided parental/own education into five categories collected during 1991-2009. (1) No Education (including household head /respondent who never went to school; they could be either literate or illiterate). (2) Primary Education (household head /respondent whose education years were between 1 and 6 years and either graduated from elementary school or went but never finished elementary school). (3) Secondary Education (household head /respondent whose education years were between 7 and 12 years, either graduated from junior high school/ high school or went but never finished junior high school/ high school). (4) Some College/College/Graduate (household head /respondent whose education years go beyond 13 years and at least went to college)

(b) Social mobility

In this study, I have defined social mobility into five categories (1) Staying at Ceiling (parental SES and own SES both at top). (2) Upward social mobility (respondent's SES is at a higher status than their parental SES, including individuals who moved up to the highest SES). (3) Downward social mobility (respondent's SES is at a lower status than their parental SES, including individuals who moved down to the lowest SES). (4) Immobility (parental SES and respondent's SES remained the same). (5) Dwelling on the bottom (parental SES and respondent's SES both at the bottom)

Finally, in order to compare the results with past studies; I also divided social mobility into three categories by traditional social mobility. The traditional categories include, (1) Upward social mobility (respondent's SES is at a higher status than their parental SES). (2) Downward social mobility (respondent's SES is at a lower status than their parental SES. (3) Stable, people whose parental SES and own SES remained the same. The definition of social mobility is presented in Table 3-2.

Covariates/control variables

In this study, I categorized occupations into three groups (1) Professional employees. Included in this category are senior professional workers (doctor, professor, lawyer, architect, and engineer); junior professional workers (midwife, nurse, teacher, editor, and photographer); administrator, executive, manager (working proprietor, government official, section chief, department or bureau director, administrative cadre, village leader); athlete, actor, and musician. (2) Service workers. Occupations in this category include, office staff (secretary, office helper); helper (housekeeper, cook, waiter, doorkeeper, hairdresser, counter salesperson, launderer, and child care worker); driver;

army officer, police officer, ordinary soldier and policeman. (3) Manual laborers (reference group): farmer, fisherman, hunter, non-skilled worker (ordinary laborer, logger) and skilled worker (foreman, group leader, craftsman) are grouped into this category.

Household gross income was built by adding each household's nine potential sources of income: business, farming, fishing, gardening, livestock, non-retirement wages, retirement income, subsidies, and other income. When any component was incomplete, an attempt was made to impute the missing data. Details of the imputation have been described in China Health and Nutrition Survey - Carolina Population Center. For interpretability, household income inflated to the year 2011.

Past studies indicate that age and marital status are important predictors of weight status among adults (Gallagher, et al., 1996; Ogden, et al., 2006; Pilote, et al., 2007). For example, married individuals have higher BMIs than their never married counterparts (Pilote, et al., 2007). In addition, weight gain is related to aging, and people tend to gain substantial weight during middle age (Bennett, et al., 2008). Furthermore, studies show that there is significant regional and rural-urban weight disparity in China (Li, et al., 2008). Based on the findings, I have controlled (1) Current age; (2) marital status, (3) province, and (4) residential area divided into rural and urban in all the regression models.

Because of the problem of collinearity in longitudinal regression models, the time indicators should be either age or survey year (Singer & Willett, 2003); I has chosen "current age" as the time indicator. Current age in this study was recoded as age minus 18 from 0 (18) to 37 (55) and entered as a continuous variable.

*Statistical Analyses*

Due to gender differences in the association of SES and body weight status (Gonzalez et al., 2009; McLaren, 2007; Senese et al., 2009), the study uses sex-stratified multilevel (hierarchic) linear regression models to estimate the SES-specific change in BMI over 1991-2009 by gender. All models are controlled by age, marital status, province, and residential area. The multilevel approach has taken the dependence among observations, individuals, and households into account. In these "random intercept" models, the intercepts are randomly varied across higher-level units, and all of the regression coefficients are treated as fixed. The models include random intercepts for each participant to account for the BMI measurements within a person over time. In these models, the "cluster" is each individual's, repeated measurement in each year is nested (level 2); and applied to households (level 3). All the models are estimated with Stata 13 software.

**Table 3-1: Characteristics of the Analytic Samples and Measurements in Each Study**

| | Topic | Year | Age Range | Sample Size | Dependent Variable | Independent Variable |
|---|---|---|---|---|---|---|
| **Study 1** | The Effect of Household Technology on Body Mass Index | 1997-2009 | 18-55 | 13,037 | BMI | Household Technology |
| **Study 2** | Obesity Pay Gap: Gender, Body Size, and Wage Inequalities | 1991-2009 | 18-55 | 12,076 | Wage | BMI |
| **Study 3** | Socioeconomic Status, Social Mobility, and Body Weight | 1991-2009 | 18-55 | 7,277 | BMI | Social Mobility |

**Table 3-2: The Definitions of Social Mobility**

| | | The definition of social mobility in this study | | | | |
|---|---|---|---|---|---|---|
| | | Stuck | Downward | Immobile | Upward | Ceiling |
| The definition of social mobility in past studies | Downward | | × | | | |
| | Stable | × | | × | | × |
| | Upward | | | | × | |

# CHAPTER 4

## THE EFFECT OF HOUSEHOLD TECHNOLOGY ON BODY MASS INDEX

*Percent of Individuals with Each Form of Household Technology 1997–2009.*

Table 4-1 shows the trend for individuals within households in CHNS possessing each form of technology since 1997. The sample shows that Chinese individuals experienced a rapid rate of household technology transition. Most individual technology possession rates increased considerably. For example, only half of individuals have a TV at home in 1997, but 99.10% of individuals have at least one by 2009. While only about one-third to three-fifths of individuals living in the home owned a washing machine, food preparation technology, or communication device in 1997, more than half of individual possessed at least one washing machine (79.35%), food preparation technology (94.27%), and communication device (97.04%) in 2009. On the other hand, comparing other household technologies, the number of individuals living in the home and owned a computer (32.15%), air conditioner (31.03%) and modern vehicles (49.53%) are still relatively low in 2009.

*Background Characteristics*

Table 4-2 presents our sample on the prevalence of obesity, mean BMI, and individual background characteristics by gender. I found that the average BMI also increased substantially from 22.12 kg/$m^2$ to 23.44 kg/$m^2$ among males and from 22.47 kg/$m^2$ to 23.12 kg/$m^2$ among females during 1997–2009. The prevalence of obesity increases from 14.57% to 30.36% among males and 18.74% to 26.49% among females from 1997 to 2009.

Reduced exercise and increased dietary consumption have been blamed as drivers of the obesity epidemic; yet, our sample indicated that these trends moved in the opposite direction during 1997–2009. The total energy intake (kcal) decreased while energy expenditure in exercise (METs) increased. This is similar to the findings from other studies using the same database (Du, et al. 2002; Ng and Popkin 2012; Ng 2009). Our selected sample also shows that occupational physical levels have decreased considerately, especially for women, from 321.85 (METs) in 1997 to 193.63 (METs) in 2009. Finally, physical activity in transportation has decreased for both men and women, while home activity has increased. Generally, our sample shows that there were substantial changes in lifestyle and behavior among Chinese adults during the past 12 years.

*Causal Effects of Ownership of Household Technology on an Individual's BMI, 1997–2009.*

FE models are intended to investigate the causes of changes within a person. The results of FE regression models examining the causal effects of the ownership of household technology on the mean BMI between 1997 and 2009 by gender are provided in Tables 4-3. I have controlled the possible time-varying covariates in all models, including survey year, age, age square, marital status, individual and household SES, and current smoking status. The full models further control the variations of total daily energy intake, energy expenditure in exercise, and physical levels in occupational, transportation and home activity, during 1997–2009.

Model 1 indicates that each food preparation technology increases BMI by.06 ($*p < .05$), and an air conditioner increases BMI by .17 in men ($*p < .05$). In other words, for a man of average height (164.8 cm) in China, adopting one food preparation technology increases his weight by .16 kg [(1.65 m) $^2$ × (.06 kg/m$^2$)) =.16 kg]. Adopting a refrigerator, microwave, rice maker and pressure cooker increase an average man's weight by .64 kg (.16 kg ×4=.64 kg). Adopting an air conditioner increased his weight by .49 kg. Model 1 also shows that age is positively related to body mass index; getting a year older increases BMI by .497 kg/m$^2$; the results also show a nonlinear relationship between age and BMI. Quitting smoking decreases BMI by .228 kg/m$^2$, and every percent household income increases is related to a BMI increase of .035 kg/m$^2$. Model 2 indicates that after adjusting for physical activities and dietary intake, there is very little change in the coefficients of household technologies compared to Model 1; which means that exercise and dietary intake do not function as mediators for the association between household technology and BMI in men.

For women, owning a washing machine increases BMI by .11 (*$p$ < .05), and four food preparation technologies increase her BMI by .22 kg/m$^2$ (*$p$ < .05, Model 3) [(.055 kg/m$^2$) ×4=.22 kg/m$^2$]. For a woman of average height (154.5 cm) in China, this is equivalent to adding .26 kg and .44 kg, respectively. Unexpectedly, our sample also indicates that owning a computer at home decreases female BMI by .18 or .27 kg (**$p$ < .01). Age is positively related to women's body size; getting a year older increases BMI by .267 kg/m$^2$, and there is a nonlinear relationship between age and BMI. Model 4 indicates that exercise and dietary intake did not function as mediators for the association between household technology and BMI in women; but the changes of METs in exercise, home and occupational activity have significant effects on BMI during 1997–2009.

**Table 4-1: Percent of individuals owning each household technology by wave (CHNS 1997-2009)**

| | **Year** | | | | |
|---|---|---|---|---|---|
| | **1997** | **2000** | **2004** | **2006** | **2009** |
| **Observation (Individuals)** | **5091** | **5246** | **5781** | **5454** | **5568** |
| Household technologies | | | | | |
| Television (%) | 53.09 | 72.21 | 88.51 | 94.83 | 99.10 |
| Computer (%) | 2.02 | 5.13 | 11.52 | 16.70 | 32.15 |
| Washing machine (%) | 51.80 | 57.51 | 63.92 | 70.02 | 79.35 |
| Food-preparation technology (%) | 61.66 | 74.29 | 81.02 | 87.07 | 94.27 |
| Air conditioner (%) | 5.15 | 9.21 | 18.85 | 22.52 | 31.03 |
| Communication device (%) | 30.84 | 51.94 | 82.04 | 87.64 | 97.04 |
| Modern vehicle (%) | 16.19 | 25.94 | 36.83 | 41.55 | 49.53 |

*Note*: Here observations refer to individuals in the sample having two or more observations during 1997-2009 and were included in our final fixed-effects linear regression.

**Table 4-2: Descriptive statistics of individual level variables by gender (CHNS 1997 & 2009)**

| | Male | | Female | |
|---|---|---|---|---|
| | 1997 | 2009 | 1997 | 2009 |
| **Observation (Individuals)** | **2492** | **2665** | **2599** | **2903** |
| **Dependent variable** | | | | |
| Body mass index (kg/m$^2$) | 22.12 | 23.44 | 22.47 | 23.12 |
| | (2.75) | (3.38) | (2.98) | (3.38) |
| Obesity (%; BMI ≥ 25) | 14.57 | 30.36 | 18.74 | 26.49 |
| **Control variables** | | | | |
| Age (years) | 37.21 | 40.69 | 37.88 | 41.20 |
| | (10.24) | (9.87) | (9.79) | (9.62) |
| Log household income | 9.36 | 10.20 | 9.37 | 10.17 |
| | (.75) | (1.45) | (.78) | (1.37) |
| Household gross income (per 1,000) | 15.09 | 46.60 | 15.14 | 43.54 |
| | (12.60) | (75.58) | (12.46) | (61.66) |
| Education (%) | | | | |
| No education | 9.63 | 5.37 | 27.47 | 15.02 |
| Primary education | 63.96 | 60.11 | 52.64 | 57.18 |
| Secondary education | 22.87 | 26.75 | 17.62 | 21.77 |
| College and above | 3.53 | 7.77 | 2.27 | 6.03 |
| Married (%) | 79.65 | 83.26 | 84.88 | 89.08 |
| Currently smoking (%) | 64.77 | 58.87 | 3.08 | 2.00 |
| **Mediating variables** | | | | |
| Daily energy intake (kcal) | 2.64 | 2.46 | 2.26 | 2.05 |
| | (.71) | (1.36) | (.60) | (.79) |
| Exercise (MET-hrs/week) | 4.33 | 5.35 | 1.62 | 3.51 |
| | (14.78) | (19.13) | (9.10) | (14.24) |
| **Physical activity (MET-hrs/week)** | | | | |
| Occupation | 342.07 | 266.32 | 321.85 | 193.63 |
| | (213.65) | (222.41) | (210.31) | (191.25) |
| Transportation | 2.02 | .78 | 1.84 | .83 |
| | (3.32) | (1.71) | (3.12) | (2.29) |
| Home | 7.95 | 11.18 | 34.81 | 47.81 |
| | (15.80) | (21.49) | (24.46) | (52.77) |

*Note 1*: The table only presents sample in the baseline, 1997, and the final wave, 2009
*Note 2:* Standard deviations in parentheses
*Note 3*: Here observations refer to individuals in the sample having two or more observations during 1997-2009 and were included in our final fixed-effects linear regression.

**Table 4-3: Fixed-effects liner regression for the ownership of household technology predicting mean BMI by gender (CHNS 1997-2009)**

| | Male | | Female | |
|---|---|---|---|---|
| **Variables** | (1) | (2) | (3) | (4) |
| **Household technologies** | | | | |
| TV | .021 | .020 | .057 | .046 |
| | (.059) | (.059) | (.056) | (.056) |
| Computer | .098 | .098 | -.177** | -.169** |
| | (.060) | (.060) | (.058) | (.058) |
| Washing machine | -.033 | -.032 | .106* | .104* |
| | (.050) | (.051) | (.049) | (.049) |
| Food technologies | .064* | .064* | .055* | .052* |
| | (.025) | (.025) | (.024) | (.024) |
| Communication device | .009 | .008 | .040 | .037 |
| | (.035) | (.035) | (.034) | (.034) |
| Air conditioner | .171* | .170* | .011 | .025 |
| | (.067) | (.067) | (.064) | (.064) |
| Motorized vehicle | .013 | .011 | .043 | .037 |
| | (.042) | (.042) | (.041) | (.041) |
| **Covariates** | | | | |
| Age | .497*** | .497*** | .267** | .263** |
| | (.091) | (.091) | (.085) | (.085) |
| Age$^2$ | -.003*** | -.003*** | -.001*** | -.001*** |
| | (.001) | (.001) | (.001) | (.001) |
| Married | .006 | .003 | -.010 | -.012 |
| | (.079) | (.079) | (.098) | (.098) |
| Currently smoke | -.228*** | -.228*** | -.172 | -.177 |
| | (.049) | (.049) | (.155) | (.155) |
| Log household income | .035* | .035* | .013 | .013 |
| | (.014) | (.014) | (.014) | (.014) |
| Education (*ref.=No education*) | | | | |
| Primary | .057 | .059 | -.088 | -.088 |
| | (.105) | (.105) | (.076) | (.076) |
| Secondary | .092 | .095 | -.146 | -.142 |
| | (.136) | (.136) | (.122) | (.122) |
| College and above | .039 | .045 | -.511* | -.497* |
| | (.185) | (.185) | (.198) | (.198) |
| **Mediating variables** | | | | |
| Dietary intake | | -.003 | | -.010 |
| | | (.017) | | (.023) |
| Exercise | | -.000 | | -.003* |
| | | (.001) | | (.001) |
| **Physical activity** | | | | |
| Occupation | | -.005 | | -.035*** |
| | | (.010) | | (.010) |
| Transportation | | -.007 | | .005 |
| | | (.007) | | (.007) |
| Home | | .001 | | .001† |
| | | (.001) | | (.000) |
| **Constant** | 8.673** | 8.693** | 14.283*** | 14.565*** |
| | (2.953) | (2.956) | (2.796) | (2.798) |
| **Observations** | 13,037 | 13,037 | 14,103 | 14,103 |

*Note 1*: Two-tailed tests; standard deviations in parentheses*** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$
*Note 2*: All models were adjusted for survey year 1997-2009

# CHAPTER 5

# OBESITY PAY GAP: GENDER, BODY SIZE, AND WAGE INEQUALITIES

## *Body Mass Index and Wage by Men and Women*

Table 5-1 presents descriptive statistics by person-year divided by gender. These are means averaged across all person-years from 1991 to 2009. Both men and women are more likely to be manual workers. Women have slightly more health constraints, while men are older and more likely to be married, receive more education, and work longer hours per day. The average wage for men (770 yuan/month) is also higher than women (579 yuan/month).

On average, body mass index is slightly higher for men (23.00 kg/m2) than women (22.41 kg/m2); and overweight and obesity rate (BMI≥23) is also higher for men (45.96 %) than women (38.21 %).

The sample shows a slightly higher prevalence of overweight and obesity compared to estimates by the World Health Organization's Global Info Database, which indicates that 45% of male and 32% of female adults in China were categorized as overweight or obese in 2010 (Patterson, 2011).

## *Weight Wage Disparities by Occupation and Gender*

Table 5-2 presents the estimate effects of BMI on log wages during 1991-2009 separated by gender based on FE linear regression. Survey year, age, educational years, marital status, health constraints, working hours, and household fixed-effects are controlled in all models. In these models, all coefficients refer to the percent change in wages. Further, I examine whether the effects of BMI on wage vary by occupational groups in model 3 and 6. The quadratic model of the relationship between BMI and wages provides similar outcomes to the liner relationship between BMI and wages and thus only the linear specification is shown. In addition, there was no nonlinear relationship between wage and underweight, normal weight, overweight, or obesity and it was omitted from the final models.

The results show that, for women, there is no association between BMI and wage. A year age increase is related to 1 % wage increase for women. There is no association between wage and education, working hours, marital status, or health constraints (Model 1). After controlling the occupational groups does not alter the coefficients of BMI on wages (Model 2), and there is no evidence to indicate the effect of BMI on wages varies by occupation (Model 3). For men, increasing BMI does not cause a wage increase in general. A year education increase is related to 1 % wage increase. There is no association between wage and age, working hours, marital status, or health constraints, and there is no evidence to indicate the effect of BMI on wages varies by occupation (Model 4); controlling the occupational groups also does not change the effects of BMI on wage outcomes (Model 5). However, the effects of BMI on wages differ across occupations (Model 6), showing there is increasing wage disparities by occupation when gaining weight. In order to provide a good understanding of wage change by BMI in one occupation type relative to the reference category (manual laborers), I further estimate the marginal effect of body mass index on wages by occupations. The results are presented in Figures 5-1 (female) and 5-2 (male) depicting the outcomes from Table 5-3.

Table 5-3 shows that the wage disparity between professional workers and service workers relative to manual labors increases by BMI for men but not for women. Figure5-1 also shows that the wage disparity does not differ by occupation for women.

Conversely, Figure 5-2 indicates that the wage gap between male between professional workers and service workers and manual laborers increases linearly and significantly after BMI reaches 23, the Pacific criteria for overweight. Specifically, male overweight professional workers make 9.3% – 13.9% more than manual laborers, and obese professional workers earn 18.5 % – 41.5% more than manual laborers. Overweight service workers make 9.3% – 11.8% more than manual laborers, and obese service based workers earn 14.2% –26.4% more than manual laborers (Table 5-3). Note that only 2.61 % of males in the sample have BMI over 30 and is not presented in my Figures; the results show the wage disparities continue to increase for these extreme cases.

**Table 5-1: Descriptive Statistics by Person-year and Gender, CHNS 1991-2009**

| | Female (N=5,103) | | | | | Male (N=6,901 ) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | n | % | Mean | S.D. | [range] | n | % | Mean | S.D. | [range] |
| BMI (kg/m$^2$) | | | 22.41 | 3.00 | [14.89, 40.35] | | | 23.00 | 3.14 | [14.52, 42.72] |
| Age (year) | | | 36.29 | 8.93 | [18.03, 55.00] | | | 38.17 | 9.55 | [18.01, 54.99] |
| Education (year) | | | 10.27 | 3.67 | [0, 18] | | | 10.28 | 3.41 | [0, 18] |
| Working hours (day) | | | 6.17 | 1.76 | [.07, 15.78] | | | 6.19 | 1.85 | [.01, 17.75] |
| Wage (per 100 yuan/month) | | | 5.79 | 8.43 | [.02, 240] | | | 7.70 | 14.66 | [.10, 400] |
| Log wage | | | 5.82 | 1.06 | [1.10, 10.09] | | | 6.03 | 1.10 | [2.40, 10.60] |
| Weight Status | | | | | | | | | | |
| Obesity (BMI $\geq$ 25) | 962 | 18.85 | | | | 1,737 | 25.17 | | | |
| Overweight ( $23 \leq$ BMI$<25$) | 988 | 19.36 | | | | 1,435 | 20.79 | | | |
| Normal weight ( $18.5 \leq$ BMI$<23$) | 2,803 | 54.93 | | | | 3,372 | 48.86 | | | |
| Underweight (BMI<18.5) | 350 | 6.86 | | | | 357 | 5.17 | | | |
| Occupation | | | | | | | | | | |
| *Manual laborers* | 2,100 | 41.15 | | | | 3,253 | 47.14 | | | |
| *Non-manual laborers* | | | | | | | | | | |
| Professional employees | 1,347 | 26.40 | | | | 2,012 | 29.16 | | | |
| Service workers | 1,656 | 32.45 | | | | 1,636 | 23.71 | | | |
| Health Constraints | | | | | | | | | | |
| No | 4,700 | 92.10 | | | | 6,412 | 92.91 | | | |
| Yes | 403 | 7.90 | | | | 489 | 7.09 | | | |
| Marital Status | | | | | | | | | | |
| Non-married | 927 | 18.17 | | | | 1,104 | 16.00 | | | |
| Married | 4,176 | 81.83 | | | | 5,797 | 84.00 | | | |

**Table 5-2: BMI on Wage Outcomes Based on Linear Fixed-effect Regression Models by Gender, CHNS 1991-2009**

| | Female (N=5,103) | | | Male (N=6,901) | | |
|---|---|---|---|---|---|---|
| VARIABLES | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
| BMI | -.002 | -.002 | -.004 | .001 | .001 | -.022* |
| | (.011) | (.010) | (.015) | (.009) | (.009) | (.011) |
| Age (aged 18=0) | .476* | .479* | .472* | .175 | .178 | .185 |
| | (.203) | (.202) | (.202) | (.175) | (.175) | (.173) |
| Education (years) | .011 | .010 | .010 | .029* | .028* | .027* |
| | (.012) | (.012) | (.012) | (.013) | (.013) | (.013) |
| Working hours (day) | .016 | .016 | .016 | .014 | .011 | .012 |
| | (.011) | (.011) | (.011) | (.010) | (.010) | (.010) |
| Married (ref.=non-married) | -.011 | -.012 | -.012 | .081 | .079 | .094 |
| | (.066) | (.066) | (.066) | (.057) | (.057) | (.058) |
| Health constraints | -.072 | -.073 | -.072 | .038 | .043 | .053 |
| (ref.=no health constraints) | (.057) | (.057) | (.057) | (.051) | (.051) | (.051) |
| Manual laborers | | | | | | |
| Professional employees | | .034 | -.066 | | .100† | -.962*** |
| | | (.061) | (.407) | | (.054) | (.287) |
| Service workers | | -.019 | -.210 | | .081† | -.468 |
| | | (.052) | (.350) | | (.047) | (.313) |
| Manual laborers ×BMI | | | | | | |
| Professional employees ×BMI | | | .002 | | | .046*** |
| | | | (.018) | | | (.012) |
| Service workers × BMI | | | .010 | | | .024† |
| | | | (.015) | | | (.014) |
| Constant | -.426 | -.498 | -.381 | 2.134 | 2.084 | 2.491 |
| | (2.039) | (2.037) | (2.037) | (2.085) | (2.086) | (2.074) |
| R-squared | .93 | .93 | .93 | .92 | .92 | .92 |
| Adj. R-squared | .85 | .85 | .85 | .83 | .83 | .83 |

*Notes:* All models controlled for survey wave (1991-2009), individual, and *household* fixed effects.
Robust standard errors are reported in parentheses *** $p$<.001, ** $p$<.01, * $p$<.05, †$p$<.10

**Table 5-3: Marginal Effect of Body Size on Log Wage by Occupations**

| WHO Weight Status Definition | | BMI | Female | | Male | |
|---|---|---|---|---|---|---|
| Pacific region criteria | Universal criteria | | Professional employees | Service workers | Professional employees | Service workers |
| Underweight | Underweight | 18 | .038 | -.060 | -.136† | -.029 |
| | | | (.106) | (.089) | (.080) | (.081) |
| | | 19 | .036 | -.051 | -.090 | -.004 |
| | | | (.092) | (.077) | (.071) | (.070) |
| | | 20 | .035 | -.043 | -.044 | .020 |
| | | | (.080) | (.067) | (.063) | (.061) |
| | | 21 | .033 | -.035 | .002 | .045 |
| | | | (.069) | (.058) | (.057) | (.053) |
| | | 22 | .032 | -.026 | .048 | .069 |
| | | | (.063) | (.053) | (.054) | (.048) |
| Overweight | | 23 | .030 | -.018 | .093† | .093* |
| | | | (.060) | (.052) | (.053) | (.046) |
| | | 24 | .029 | -.010 | .139* | .118* |
| | | | (.063) | (.055) | (.055) | (.046) |
| Obesity | Overweight | 25 | .027 | -.001 | .185** | .142** |
| | | | (.069) | (.062) | (.060) | (.054) |
| | | 26 | .026 | .007 | .231** | .167** |
| | | | (.080) | (.071) | (.066) | (.062) |
| | | 27 | .024 | .016 | .277*** | .191** |
| | | | (.092) | (.082) | (.075) | (.072) |
| | | 28 | .023 | .024 | .323*** | .216** |
| | | | (.106) | (.095) | (.084) | (.083) |
| | | 29 | .021 | .032 | .369*** | .240* |
| | | | (.121) | (.108) | (.094) | (.095) |
| | Obesity | 30 | .020 | .041 | .415*** | .264* |
| | | | (.136) | (.121) | (.104) | (.107) |

*Notes:* I run separate models by gender subgroups, controlling survey year, age, education, working hours, marital status, health constraints, and household fixed effects. The unit of analysis is person-years. Standard errors are in parentheses. Estimates displayed in the table are calculated marginal effects from the interaction terms of BMI with occupations, using the category of "manual laborers" as the reference group. *** $p$<.001, ** $p$<.01, * $p$<.05, †$p$<.10

**Figure 5-1 Occupation Wage Differentials by Body Mass Index (Female)**

Conditional Marginal Effects with 95% CIs

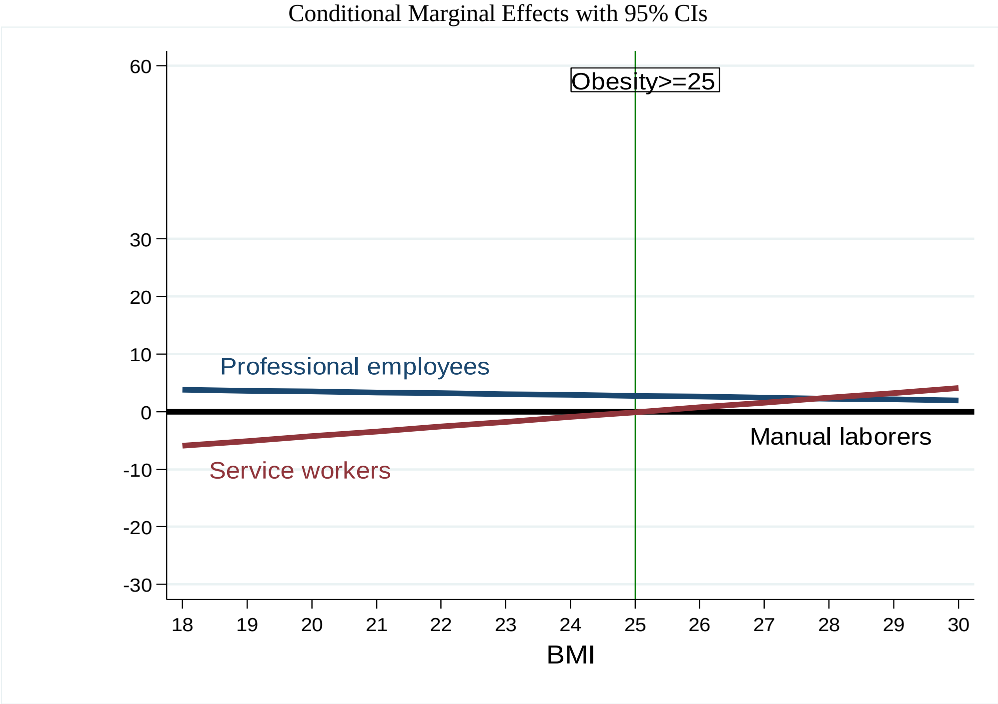
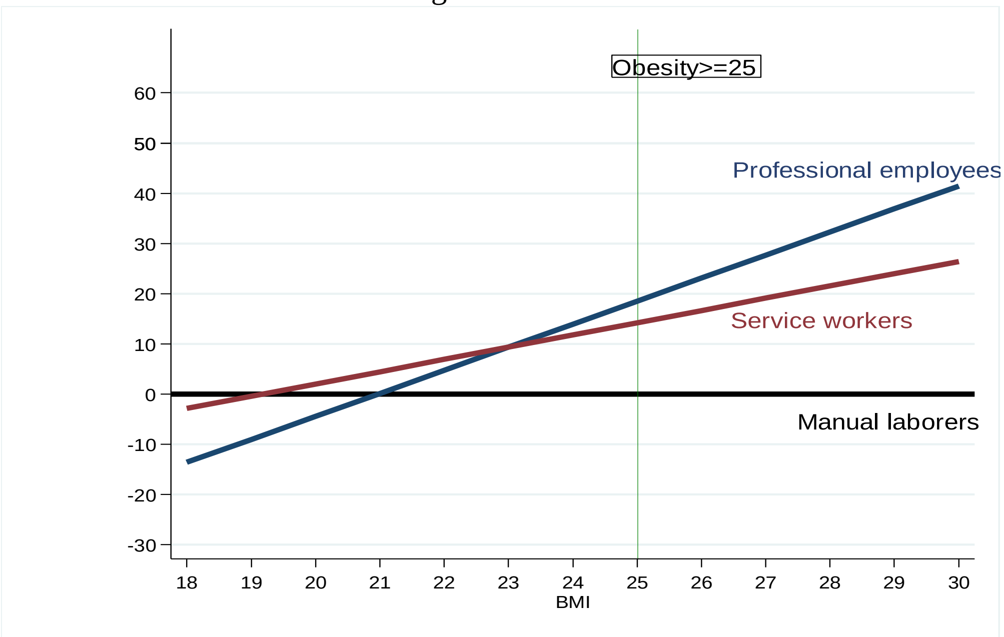



**Figure 5-2 Occupation Wage Differentials by Body Mass Index (Male)**

Conditional Marginal Effects with 95% CIs




*Notes:* The solid line represents the marginal effects of a unit increase in the BMI. The horizontal line represents the reference group, manual laborers. *** $p$<.001, ** $p$<.01, * $p$<.05, †$p$<.10

# CHAPTER 6

## SOCIOECONOMIC STATUS, SOCIAL MOBILITY, AND BODY SOZE

### *Description of Participant Demographic and Socioeconomic Characteristics*

Table 6-1 presents descriptive statistics by person-year divided by gender. These statistics are means averaged across all person-years from 1991 to 2009. Table 6-1 shows that the average BMI for men (21.81 kg/$m^2$) is slightly higher than women (21.03 kg/$m^2$). The average age for men (27.96) is also higher than women (23.96); while the average household gross income for men is 32,260 yuan and for women is 27,960 yuan.

Men, women, and their fathers/mothers (household heads) are more likely to receive primary education. Both men and women are more likely to be manual laborers and resident in rural areas. According to the definition of social mobility in the current study, men and women are both more likely to experience upward social mobility; on the other hand, men and women are more likely to stay in the same SES using social mobility definition in past studies.

Since 1998, the Chinese government has devoted itself to enhancing Chinese education levels; it was not a surprise that the most individuals in the sample show an upward social mobility when using education as SES indicator. Since the social inequality is more likely to reflect on occupations, I have also compared individuals' occupations to that of the head of the household. Table 6-2 shows descriptive statistics by person-year divided by gender using occupation as SES indicator. It shows very similar sample characteristics except that more individuals were "stuck" in lowest socioeconomic ladders when using occupation as SES indicator, compared to the results with Table 6-1.

*Body Mass Index and Its Relationship with Socioeconomic Status and Social Mobility in China*

Table 6-3 and Table 6-4 represent the multilevel linear regression analysis of respondent's SES, parental SES, and social mobility variables on body mass index.

Table 6-3 shows that for women, higher own SES is associated with lower body weight; age is significantly related to body mass index, and married women are more likely to have higher BMI. On the other hand, there is no evidence show that household income, occupation, or residential area is significantly associated with BMI (Model 1). Higher parental SES is also associated with lower body weight (Model 2). However, after controlling for own SES, the association between parental SES and body weight becomes insignificant (Model 3), indicating that body weight is determined by own SES. Model 4 shows that social mobility, defined by past studies with three categories, has no impact on current body weight; after controlling parental SES, women who experienced upward social mobility have significantly lower body mass index compared to those who remained in same socioeconomic ladder as their father (Model 5).

Model 6 shows the association between body weight and social mobility using the definition with 5 categories in current study. The results show that women who stayed in the same SES with her father/mother (social immobility) have lower weight compared to women who were stuck on the bottom of the SES ladder. Furthermore, women who experienced upward social mobility also have lower body mass index compared with those who were stuck. Women who occupied the ceiling show no advantage in terms of body mass index compared to those who were stuck on the bottom or experienced downward social mobility. Model 7 shows that after controlling parental SES, only women who experienced upward social mobility have a significant decrease in body weight. In other words, women who were in the highest SES ladders and also remained in the same SES ladders in their adulthood do not enjoy better consequence in terms of body weight. Finally, comparing to Model 2 and Model 7, it indicates that parental SES may have greater impact when taking social mobility into account; indicating social mobility could be a mediator between parental SES and body mass index.

Table 6-4 shows that for men; higher own SES is associated with heavier body weight. Men who are professional or service employees are significantly heavier than manual laborers; married men have significantly heavier weight, and aging is positively related to body mass index. On the other hand, there is no evidence to show that household income and residential areas are related to BMI (Model 1). Parental SES has no impact on male body mass index (Model 2). Controlling parental SES explains part of the association between own SES and current body weight (Model 3). In addition, social mobility is not a predictor for current body weight (Model 4); after controlling parental SES, men who experienced upward social mobility have significantly heavier body weight. There is no difference in body weight among men when comparing those who were stuck on the bottom, those who occupied on the ceiling and those who experienced immobility (Model 6).Social mobility may function as mediator between parental SES and body mass index for men (Model 2 & Model 7).

Finally, I also examine occupation as parental/own SES indicator; the results are very similar to using education as an indicator with trivial associations between parental/own, social mobility, and body mass index; therefore, the analysis using occupation as indicators is omitted in final tables.

**Table 6-1: Descriptive Statistics and Frequency (Education)**

| | | Male (N=4,897) | | Female (N=2,380) | |
|---|---|---|---|---|---|
| | | Mean | S.D. | Mean | S.D. |
| BMI | | 21.81 | 2.92 | 21.03 | 2.46 |
| Age | | 27.96 | 7.21 | 23.96 | 5.54 |
| Individual household gross income (per 1,000 yuan) | | 32.26 | 47.37 | 27.96 | 28.80 |
| | | n | % | n | % |
| Parental SES | | | | | |
| Household head's education | No education | 1989 | 40.62 | 873 | 36.68 |
| | Primary education | 2303 | 47.03 | 1166 | 48.99 |
| | Secondary education | 488 | 9.97 | 263 | 11.05 |
| | College and above | 117 | 2.39 | 78 | 3.28 |
| Own SES | | | | | |
| Respondent's education | No education | 280 | 5.72 | 207 | 8.70 |
| | Primary education | 3059 | 62.47 | 1353 | 56.85 |
| | Secondary education | 1269 | 25.91 | 652 | 27.39 |
| | College and above | 289 | 5.90 | 168 | 7.06 |
| Respondent's occupation | Manual laborers | 3253 | 66.43 | 1508 | 63.36 |
| | Service employees | 1006 | 20.54 | 558 | 23.45 |
| | Professional employees | 468 | 9.56 | 241 | 10.13 |
| | Others | 170 | 3.47 | 73 | 3.07 |
| Marital status | Married | 2374 | 48.48 | 373 | 15.67 |
| | Non-married | 2523 | 51.52 | 2007 | 84.33 |
| Residential area | Urban | 1670 | 33.08 | 816 | 34.29 |
| | Rural | 3277 | 66.92 | 1564 | 65.71 |
| Social mobility defined by current study | Ceiling | 60 | 1.23 | 35 | 1.47 |
| | Upward | 2545 | 51.97 | 1193 | 50.13 |
| | Immobile | 1775 | 36.25 | 834 | 35.04 |
| | Downward | 323 | 6.60 | 183 | 7.69 |
| | Stuck | 194 | 3.96 | 135 | 5.67 |
| Social mobility defined by past studies | Stable | 2029 | 41.43 | 1004 | 42.18 |
| | Downward | 323 | 6.60 | 183 | 7.69 |
| | Upward | 2545 | 51.97 | 1193 | 50.13 |

**Table 6-2: Descriptive Statistics and Frequency (Occupation)**

| | | Male (N=3, 432) | | Female (N=1,882) | |
|---|---|---|---|---|---|
| | | Mean | S.D. | Mean | S.D. |
| BMI | | 21.35 | 2.64 | 20.99 | 2.34 |
| Age | | 25.86 | 5.85 | 22.95 | 4.52 |
| Individual household gross income (per 1,000 yuan) | | 29.74 | 50.69 | 26.33 | 27.69 |
| | | n | % | n | % |
| Parental SES | | | | | |
| Household head's occupation | Manual laborers | 2582 | 75.23 | 1339 | 71.15 |
| | Service employees | 582 | 20.09 | 378 | 20.09 |
| | Professional employees | 268 | 7.81 | 165 | 8.77 |
| Own SES | | | | | |
| Respondent's occupation | Manual laborers | 2568 | 74.83 | 1324 | 70.35 |
| | Service employees | 405 | 11.80 | 259 | 13.76 |
| | Professional employees | 459 | 13.37 | 299 | 15.89 |
| Respondent's education | No education | 221 | 6.44 | 187 | 9.94 |
| | Primary education | 2311 | 67.34 | 1142 | 60.68 |
| | Secondary education | 759 | 22.12 | 446 | 23.70 |
| | College and above | 141 | 4.11 | 107 | 5.69 |
| Marital status | Married | 2031 | 59.18 | 1635 | 86.88 |
| | Non-married | 1401 | 40.82 | 247 | 13.12 |
| Residential area | Urban | 895 | 26.08 | 532 | 28.27 |
| | Rural | 2537 | 73.92 | 1350 | 71.73 |
| Social mobility defined by current study | Ceiling | 129 | 3.76 | 75 | 3.99 |
| | Upward | 511 | 14.89 | 335 | 17.80 |
| | Immobile | 184 | 5.36 | 121 | 6.43 |
| | Downward | 418 | 12.18 | 242 | 12.86 |
| | Stuck | 2190 | 63.81 | 1109 | 58.93 |
| Social mobility defined by past studies | Stable | 2503 | 72.93 | 1305 | 69.34 |
| | Downward | 511 | 14.89 | 335 | 17.80 |
| | Upward | 418 | 12.18 | 242 | 12.86 |

| Table 6-3: SES and Social Mobility on Body Mass Index (Female) | | | | | | | |
|---|---|---|---|---|---|---|---|
| VARIABLES | Adulthood SES | Childhood SES | Adulthood & Childhood SES | Intergenerational Social Mobility | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Own Education (*ref.= No education* ) | | | | | | | |
| Primary | -.413* | | -.389* | | | | |
| | (.191) | | (.191) | | | | |
| Secondary | -.928*** | | -.874*** | | | | |
| | (.221) | | (.224) | | | | |
| College & above | -1.274*** | | -1.205*** | | | | |
| | (.286) | | (.294) | | | | |
| Parental Education (*ref.= No education* ) | | | | | | | |
| Primary | | -.291* | -.190 | | -.535*** | | -.510** |
| | | (.117) | (.119) | | (.139) | | (.159) |
| Secondary | | -.412* | -.193 | | -.838*** | | -.810*** |
| | | (.191) | (.195) | | (.229) | | (.244) |
| College & above | | -.562 | -.221 | | -1.199** | | -1.158* |
| | | (.320) | (.329) | | (.375) | | (.501) |
| Social Mobility (*Reference)* | | | | *Stable* | *Stable* | *Stuck* | *Stuck* |
| Downward | | | | -.029 | .226 | -.499 | .140 |
| | | | | (.190) | (.209) | (.283) | (.335) |
| Immobile | | | | - | - | -.524* | -.091 |
| | | | | - | - | (.242) | (.275) |
| Upward | | | | -.129 | -.442*** | -.594* | -.508* |
| | | | | (.107) | (.128) | (.234) | (.236) |
| Ceiling | | | | - | - | -.882 | -.105 |
| | | | | - | - | (.467) | (.624) |
| Household Income (1,000 dollars) | -.001 | -.001 | -.001 | -.002 | -.001 | -.002 | -0.001 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (0.002) |
| Occupation (*ref.=manual laborers*) | | | | | | | |
| Services employees | -.066 | -.176 | -.057 | -.205 | -.116 | -.182 | -.116 |
| | (.124) | (.121) | (.124) | (.121) | (.123) | (.122) | (.123) |
| Professional employees | -.120 | -.312 | -.109 | -.359* | -.189 | -.345* | -.192 |
| | (.176) | (.171) | (.177) | (.169) | (.174) | (.169) | (.175) |
| Other | -.219 | -.289 | -.194 | -.336 | -.231 | -.319 | -.233 |
| | (.236) | (.236) | (.236) | (.235) | (.236) | (.235) | (.236) |
| Married | .813*** | .798*** | .798*** | .861*** | .814*** | .856*** | .816*** |
| | (.143) | (.141) | (.141) | (.143) | (.143) | (.143) | (.143) |
| Age | .089*** | .085*** | .085*** | .087*** | .086*** | .086*** | .086*** |
| | (.010) | (.010) | (.010) | (.010) | (.010) | (.010) | (.010) |
| Urban | -.210 | -.370** | -.370** | -.379** | -.252 | -.358** | -.253 |
| | (.139) | (.137) | (.137) | (.136) | (.139) | (.136) | (.139) |
| Constant | 20.992*** | 20.762*** | 20.762*** | 20.534*** | 21.083*** | 21.031*** | 21.143*** |
| | (.283) | (.238) | (.238) | (.226) | (.258) | (.315) | (.315) |
| Observations | 2,380 | 2,380 | 2,380 | 2,380 | 2,380 | 2,380 | 2,380 |
| (Household) | 1,288 | 1,288 | 1,288 | 1,288 | 1,288 | 1,288 | 1,288 |

*Notes:* All models controlled for provinces. Robust standard errors are reported in parentheses *** *p*<.001, ** *p*<.01, * *p*<.05, †*p*<.10

**Table 6-4: SES and Social Mobility on Body Mass Index (Male)**

| VARIABLES | Adulthood SES | Childhood SES | Adulthood & Childhood SES | Intergenerational Social Mobility | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| ***Own Education (ref.= No education )*** | | | | | | | |
| Primary | .019 | | -.000 | | | | |
| | (.170) | | (.171) | | | | |
| Secondary | .382* | | .368 | | | | |
| | (.193) | | (.195) | | | | |
| College & above | .676** | | .685** | | | | |
| | (.246) | | (.252) | | | | |
| ***Parental Education (ref.= No education )*** | | | | | | | |
| Primary | | .135 | .126 | | .348** | | .433*** |
| | | (.087) | (.088) | | (.110) | | (.123) |
| Secondary | | .181 | .064 | | .541** | | .597** |
| | | (.154) | (.157) | | (.191) | | (.202) |
| College & above | | -.020 | -.259 | | .484 | | .074 |
| | | (.316) | (.324) | | (.351) | | (.469) |
| ***Social Mobility*** | | | | *Stable* | *Stable* | *Stuck* | *Stuck* |
| Downward | | | | -.127 | -.247 | -.064 | -.446 |
| | | | | (.158) | (.177) | (.239) | (.281) |
| Immobile | | | | - | - | .041 | -.337 |
| | | | | - | - | (.201) | (.226) |
| Upward | | | | .078 | .298** | .126 | .057 |
| | | | | (.081) | (.104) | (.194) | (.195) |
| Ceiling | | | | - | - | .519 | .547 |
| | | | | - | - | (.420) | (.555) |
| ***Household Income*** | .001 | .001 | .001 | .001* | .001 | .001 | .001 |
| | (.001) | (.001) | (.001) | (.001) | (.001) | (.001) | (.001) |
| ***Occupation (ref.=Manual)*** | | | | | | | |
| Services | .468*** | .507*** | .463*** | .506*** | .476*** | .504*** | .476*** |
| | (.087) | (.087) | (.087) | (.087) | (.087) | (.087) | (.087) |
| Professional | .382** | .492*** | .381** | .489*** | .435*** | .471*** | .414*** |
| | (.122) | (.120) | (.122) | (.119) | (.120) | (.120) | (.121) |
| Other | .207 | .207 | .206 | .236 | .211 | .233 | .212 |
| | (.155) | (.155) | (.155) | (.155) | (.155) | (.155) | (.155) |
| **Married** | .398*** | .387*** | .396*** | .388*** | .391*** | .388*** | .393*** |
| | (.074) | (.074) | (.074) | (.074) | (.074) | (.074) | (.074) |
| **Age** | .112*** | .115*** | .113*** | .113*** | .114*** | .113*** | .114*** |
| | (.006) | (.006) | (.006) | (.006) | (.006) | (.006) | (.006) |
| **Urban** | -.163 | -.036 | -.147 | -.048 | -.106 | -.061 | -.104 |
| | (.122) | (.120) | (.122) | (.119) | (.121) | (.119) | (.122) |
| **Constant** | 20.589*** | 20.571*** | 20.543*** | 20.679*** | 20.326*** | 20.615*** | 20.563*** |
| | (.256) | (.215) | (.264) | (.204) | (.231) | (.278) | (.279) |
| Observations | 4,897 | 4,897 | 4,897 | 4,897 | 4,897 | 4,897 | 4,897 |
| Household | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |

*Notes:* All models controlled for provinces. Robust standard errors are reported in parentheses *** $p$<.001, ** $p$<.01, * $p$<.05, †$p$<.10

CHAPTER 7

DISCUSSION AND CONCLUSIONS

In mainland China, the prevalence of obesity has grown for people of all race/ethnicities, sex, and age. Scholars examine the rapid increase in obesity that comes after a radical change toward Western life-style in developing countries (Popkin, 1999/2001; James, et al., 2001).

CHNS was designed to examine how the social and economic transformation of Chinese society is affecting the health and nutritional status of its population. It provides information on dietary intake, health history, health-related behaviors, clinical measures of health, and body composition. Drawing on the CHNS, the first objective of this dissertation is to discuss the mechanization and modernization on a household level and capture a gendered pattern in the transition of the household technology-obesity in China.

The process of Westernization that has occurred in Asian countries has changed body image perceptions and contributed to the increasing problem of body image disturbance, especially among young women. The second objective of this dissertation is to investigate the association between gender, body mass index, occupations, and wage disparities among Chinese men and women.

The life course approach provides a perspective into how SES, acting over a lifetime, might affect the risk of obesity. The third objective of this dissertation is to gain an understanding of socioeconomic status influences on the risk of Chinese obesity using the life course perspective.

Current research has been focusing more on obesity in children and youth, and treatment of the long term impacts of obesity in elderly populations. The amount of research focused on obesity among younger adults and people in the middle of their life span has not been as large. However, it is important to pay attention to the effects of gender and age on the risk of obesity due to the increased risk of morbidity and functional disability in middle-ages, especially the large Chinese populations in these age groups; therefore, all studies in this dissertation focus on individuals between 18 and 55.

*The Effect of Household Technology on Body Mass Index*

The initial household technology adoption took place about five decades ago in Western countries, a time period for which highly accurate, representative data does not exist, and it unknown how this adoption impacted BMI increases. In China, however, the initial adoption and spread of household technology occurred much more recently. Recent empirical data collections in the CHNS provided an unprecedented opportunity to rigorously evaluate the relationship between initial and rapid household technology adoption and BMI increases. It gave us an excellent opportunity to learn from China's experience of how household technology growth triggers obesity epidemics in our rapidly developing world. Note that our study may underestimate the obesity prevalence. For example, there were 30.36% males and 26.49% females categorized as obese (BMI over 25) in 2009; which was lower than the national assessments, which shows that an average of 38.5 % of the 2010 population age 15 or over having BMI of 25 or greater (Patterson, 2010).

Our results show that food preparation technologies promote BMI increases for both men and women; I suppose that food preparation technologies may change eating habits for the entire family. For example, accessibility and convenience of microwave ovens and refrigerators may promote food cravings throughout the day. On the other hands, our study results suggest that household technology may have different impacts on BMI increases by gender due to diverse gendered household technological usage. For example, our data shows that washing machines promote BMI increases in women but not in men, while air conditioners have impact on BMI increases in men but not in women. This may suggest that washing machines decrease the low-intensity activities at home that are primarily carried out by women, and air conditioners may encourage men to spend a larger portion of their time engaged in sedentary activity at home during the hot summer season. The most puzzling finding is that having a computer is associated with a decrease in weight for women. Computer adoption in the Chinese households is relatively new, and longer follow-up studies will help us understand the true nature of its impact. On the other hand, with increasing social values that cite skinny as Chinese women's new identity (Chen, Gao, & Jackson, 2007; Leung, Lam, & Sze, 2001; Luo, Parish, & Laumann, 2005; Xu, et al., 2010), adopting a computer at home may allow women to control their weight efficiently by gaining knowledge and social support from internet forums, weblogs, social blogs, etc. In short, future research may be directed to investigate gender differences in household technology related to health risk behaviors. Understanding the mechanisms of household technology that trigger weight gain has important public health implications. Current public intervention against obesity has focused on promoting education programs that encourage exercise and healthy eating. Future public health policy may evaluate interventions focused on increasing low-intensity activities impacted by household technologies.

I further test whether exercise and daily energy consumption function as mediators for the association between household technology and body mass index and did not find significant effects. In fact, our sample showed that the energy expenditure in exercise increased, while daily energy consumptions decreased from 1997–2009; our findings are similar to other studies (Du, et al., 2002; Ng & Popkin 2012; Ng, Norton, & Popkin, 2009). I posit that adopting household technology may facilitate the decline of low intensity activity, such as chores around the house or hand washing clothes, which is the mechanism that triggers BMI increases, independent from exercise and daily calorie consumption. Finally, past studies showed that owning a washing machine and food preparation technology is related to a significant increase in weight for men and women (Monda, et al., 2008). Our FE models have shown that adopting washing machines has no effect on men. Other scholars found that adopting motorized vehicles promotes weight gain (Bell, et al., 2002; Qin, et al., 2012). Our results did not find significant impact from motorized vehicles on weight gain in women or men. I argue that past studies investigating the associations between Chinese household technologies and BMI increases draw a slightly different conclusions from us, because the associations may be confounded by time-invariant variables (Bell, et al., 2002; Monda, et al., 2008; Qin, Stolk, & Corpeleijn, 2012; Lear, et al., 2014).

There are some limitations in this study. First, owning a household technology does not mean every individual in household uses it to its full potential. Unfortunately, there is no information from CHNS about the amount of time or frequency of each technology use by each household member. Second, some time-varying variables are not taken into accounts due to the limitations of the survey. For example, most household chores such as cleaning the house and home maintenance are not included in the survey. In addition, our analysis does not account for the initial adoption of energy-saving devices in public places, such as elevators, escalators, automatic doors, etc., which also occurred recently in modern China. However, our ultimate purpose is to emphasize that rapid technology transition in developing societies may have important influences on obesity epidemics, along with the changing of physical activity and diet behaviors. Finally, the CHNS survey only followed up individuals who continue to reside in selected households in any given year; individuals who moved out their households were not followed. For that reason, I am unable to estimate the association between household technology adoption and BMI increases among individuals who no longer lived in their original household.

### *Obesity Wage Disparities*

Desire for thinness is a relatively new phenomenon; throughout history, a large body size was valued, and fatness was viewed as wealth and power (Cassidy, 1991). However, the growing economy and emerging leisure class in the early twentieth century has shifted public value from fatness as beauty to thinness in the Western societies (Cogan, et al., 1996). Scholars argue that recent Westernization in developing countries is shifting personal identity, mind and character to an increasingly visual and consumerist focus. Orbach (2006) believes that global culture is now built on body insecurity and body hatred.

Past Western studies have established the negative association between obesity and wage, especially for women (Averett & Korenman, 1996; Cawley, 2004), based on the assumptions of employment-based discrimination, schooling, and marriage market processes.  However, it is still uncertain whether the same weight-wage associations are observed in modern China. China has been undergoing rapidly rising obesity rates starting in the late 1980s (Du, et.al, 2002; Ma, et al., 2005; Wang, et al., 2006). It is important to learn from China's experience, how increasing body weight impacts individual economic well-being in the rapidly developing world.

This study presupposes that gaining weight may have different impact on wages for Chinese men and women, due to diverse and gendered perceptions of physical attractiveness in terms of body size affected by cultural perspectives. I hypothesized (1) there will be negative association between body size and wage for women. However, my results show that there are no associations between BMI and wages for women.

Past Western studies show that the obesity wage penalty is mostly found among occupations which require a greater degree of social interaction for women (Han, et al., 2009). Recently, China's government has shifted its policy away from state-run and collective-owned enterprises that primarily engaged in agricultural production to the growing service sectors and private-owned industries. Owing to the increasing interpersonal relationships in workplaces, I predicted (2) for women, wages will be most likely to be impacted by body size with occupations requiring greater interpersonal interactions in the workplace; for men, there will be no association between body size and wage regardless occupations.  My study shows there is no association between body size and wage for women; for men, professional employees or service workers make significantly superior wage compared to manual laborers when reaching the WHO Pacific region criteria for overweight ($BMI \geq 23$), and these wage gaps continue expanding with increasing body mass index, particularly when comparing professional employees to manual laborers.

Obesity has been found to be related to health quality of life, sick leave, and workplace productivity (Gates, et al., 2008; Hassan, et al., 2003; Jia & Lubetkin, 2005; Neovius, et al.,2009; Van Duijvenbode, et al., 2009). It is also well known that Asian populations are more vulnerable to obesity-attributable deaths and health concerns caused by obesity (Wen, et al., 2008). China's experience suggests that there is an urgent need for understanding the underlying mechanism by which social determinants may contribute to the rapidly growing obesity gradient. Once the causes are understood researchers and policy makers can develop effective intervention strategies and lessen the high economic burden of obesity in the developing world. Although I did not find the obesity wage penalty in women; the study calls attention to the fact that Chinese society currently does not favor heavier women by increasing their economic well-being in workplace, even though in the past plumpness was viewed as desirable and attractive in Chinese society. On the other hand, the increasing wage gaps between male professional/service workers and manual laborers indicates that current male obesity rates may be worsened by the greater economic rewards to obese non-manual workers. With increasing interpersonal interactions in the workplace in Chinese industries, and the lack of public awareness of the risks of obesity, Chinese public health strategies for preventing and controlling obesity should target male non-manual laborers, the most vulnerable population in the future.

There are some limitations for this study. My interest is to evaluate whether there is increasing weight-related employee discrimination in modern Chinese society; however, the current CHNS database does not have information for me to evaluate weight-related employee discrimination directly. In addition, unemployed individuals have been dropped out from the sample and past studies demonstrate that obese individuals are less likely to be employed compared their non-obese counterparts (Averett & Korenman, 1996; Gortmaker et al., 1993). Future study should be directed to examine whether obesity is associated with the risk of unemployment. Also, BMI is a number calculated from weight and height; as a result, muscularity or body fat can both contribute to increasing body mass index. On the other hand, taking into account that less than .25% of my sample is professional athletes, and increasing sedentary lifestyles in Chinese society, it is unlikely the wage disparities by occupations in men are caused by the muscularity rather than fatness differential. Furthermore, the simplistic classification of occupations prevents me from refining the mechanisms underlining the association between body size and wage outcomes. Whether wage disparities by occupations are due to employer, customer or colleague discrimination still needs more investigation. For example, waiter, cook, launder, and salesperson, are all grouped as “service worker” in the original questionnaire; while a waiter or salesperson require higher interactions with customers, a cook or launder may interact with customers in a lesser degree. Finally, the CHNS survey only followed up individuals who continue to reside in selected households in any given year; individuals who moved out their households were not followed. For that reason, I am unable to estimate the association between body weight and economic well- being among individuals who no longer lived in their original household.

### *Social Mobility and Body Size*

China’s economic reforms at the end of 1970s brought remarkable social and economic development (Holz, 2008; Tang, et al. 2008); while socio-economic inequalities have been widening ever since (Luo & Zhu, 2008; Chen, 2010). Li (2005) describes the inverted T-shaped social structure in modern China; the majority of the population is considered to be low class; the elites account for only a very small portion and are distributed in a pole-shaped structure with no transition in between. In other words, despite the general raising of SES of Chinese population, most people have less opportunity to advance themselves to the top circle of the society compared to the prior to the reform period. China's increasing social inequality entails those who are trapped on the bottom ladder of SES may have the highest risk of health, whereas people who dwell in the top SES may enjoy the most ideal health status. Chinese experience provides the opportunities to understand the production of social inequalities in health as well as the unequal distribution of obesity in a transitional society suffering from the ever-increasing inequalities in education, employment, and income.

Past studies have shown that minority and low socioeconomic status groups are disproportionately affected by the risk of obesity. Link and Phelan's (1995/2002) "fundamental social causes" approach argues that "individuals who control more resources of knowledge, money, power, prestige and social connections keep on achieving superior health, and the gap of economic and social factors in population health will continue to be persistent". "Fundamental social causes" explains why people with higher SES have more means to control their body weight and achieve better health.

The theory of fundamental cause of disease elucidates why the economic and social conditions are getting better in developing countries, but the highest risk population for obesity is gradually being transformed from the richest class to the poorest class. Scholars argue that past studies investigating SES and body weight applying life course approaches have shown the cumulative effects of SES on obesity without estimating the upward and downward effects of social mobility (Ball & Mishra, 2006). Although some studies have addressed that social mobility may underlie the relationship between childhood/adulthood SES and body weight (Blane, et al., 1996; Braddon, et al., 1986; Goldblatt, Moore, & Stunkard, 1965), I argue that previous social mobility studies on body weight have excluded the important information of "socially immobile" groups. People who experienced social immobility could be those who are stuck in the bottom, or those that stay on the ceiling. Being raised in a low SES family and remaining in the same SES into adulthood may have very different health outcomes compared to those who were raised from higher SES families and remind the same in adulthood. It also neglects the fact that people are immobile at highest SES and may have more ideal body weight compared to those who experienced upwardly mobility.

This study is among the few from Asia assessing the association of life course, SES, social mobility, and obesity. In the context of increasing social inequality, the study shows parental SES, own SES, and social mobility to be associated with body mass index among women. There are no associations between parental SES, social mobility, and body mass index among men, while lower own SES is associated with lower body weight. The study results support that upward social mobility had lower body weight relative to either experiencing social immobility or dwelling on the bottom of SES ladders through the life-course. In addition, parental SES has a more significant impact on current body weight for men and women after controlling social mobility, indicating that social mobility may function as mediator for the relationship between parental SES and current body mass index.

The study calls attention to the fact that women who have a chance to advance themselves with higher education compared to their parent are less likely to have excessive body weight compare to women who remained in their parental SES category. It could be those women have learned the skills and knowledge needed to maintain healthier weight by advancing their educational levels. Since high educational attainment is consistently and inversely related to body mass index for women, policy makers promoting female education, especially among those from low childhood SES, may be effective in promoting healthier weight. On the other hand, past studies show that women with higher SES are more dissatisfied with their bodies, and educational qualification is a more powerful indicator than occupational in explaining body dissatisfied (McLaren & Kuh, 2004). Women who experience educational upward social mobility may be more likely to be exposed to the shifting from transitional beauty identity, mind and character to an increasingly visual and consumerist focus on thinness as self-identity. Therefore, whether enhancing women's education promotes healthier lifestyles or leads to social hazards such as poor body image, eating disorders, and massive body plasticity needs further investigation. Future policy makers in promoting a healthy diet and regular physical activity may also include promoting positive body image in health education programs.

In this study, parental and own education seems to be more important for women's body size and is negatively associated with BMI, while parental and own education is not a good predictor of body size for men. Since I only have educational information from households where son or daughter is living with their household head, this implies that parental disadvantage may affect body mass index more powerfully in women who live with their parents owing to gender differences. On the other hand, in this study, multilevel linear regression models only draw an association between SES and body mass index. Although I am interested in the impact of SES on body mass index; multilevel linear regression models do not claim a casual relationship. Past studies have found that obese people experience extensive discrimination and stigma (Puhl & Brownell, 2001), such as discrimination in employment, barriers in education, marriage market failures, and biased attitudes from health care professionals (Puhl & Brownell, 2001; Puhl & Brownell, 2003; Glass, et al., 2010; Crosnoe, 2007; Gortmaker, et al., 1993; Schwartz, et al., 2003); however, the social consequences of being overweight and obese are more serious toward women. For example, past studies show that obese girls are less likely to receive college education compared to their non-obese counterparts, while obese boys do not differ from their peers in college enrollment (Crosnoe, 2007; Gortmaker, et al., 1993). In short, it is possible that heavier women are less likely to have high educational attainment and less likely to experience upward social mobility, because heavier women are more vulnerable to negative bias and prejudice in educational institutions.

There are some limitations for this study; first, the study only obtained the sample for those daughters or sons who lived with their household heads (mostly fathers) in any given year during 1991-2009. The study excluded individuals who did not live with their household head in any given year, resulting in only relatively young populations who have not left their original home included in the study. Second, CHNS is not a nationally representative but only represents nine provinces; therefore, the results may not apply to other parts of the country that were not part of the survey.

Finally, all my studies have stated that obesity can no longer be relegated to the domain of personal responsibility and future intervention should not focus on individual self-control approaches. In other words, economic and social factors are outside the control of individuals, and an individual information-based intervention is unlikely to be effective due to social structure (Yach, et al, 2006). In Based on this dissertation, I suggest (1) Future public health policy should evaluate interventions that are focused on increasing low-intensity activities impacted by household technologies. (2) With increasing interpersonal interactions in the workplace in Chinese industries, and the lack of public awareness of the risks of obesity; Chinese public health strategies for preventing and controlling obesity should target male non-manual laborers, the most vulnerable population in the future. (3) Promoting Chinese women to pursue higher education has the potential to reverse their body weight disadvantages; in other words, social mobility is a more important factor than women's parental and own SES, indicating that the chance to increase education is essential for promoting healthier body weight for Chinese women.

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