New Evidence on Overweight Children in Urban China

and the Role of Socioeconomic Factors

Fengxia Dong
Associate Scientist
Center for Agricultural and Rural Development
Iowa State University
fdong@iastate.edu

Helen H. Jensen
Professor
Center for Agricultural and Rural Development
Department of Economics
Iowa State University
hhjensen@iastate.edu

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.

Abstract

Problems of overweight and obesity among children have increased in China and pose a problem both for individuals as well as for public social and health care systems. This study explores factors contributing to weight problems among children age 6 to 18 years old in urban China. Data come from the 2004 China Health and Nutrition Survey. Results from a binary probit model show that parents' being overweight, some patterns of TV use, and more frequent eating in fast food restaurants influence children being overweight. Among younger children, parent's dietary knowledge was a significant factor. For adolescents, TV habits and concern about being liked by friends were significant. The results suggest that targeted nutrition education, especially for parents and adolescents, and control of TV ads are policies that may have an effect on reducing children's overweight.

Key words: China, children's nutrition, health, nutrition, obesity

New Evidence on Overweight Children in Urban China and the Role of Socioeconomic Factors

Problems of overweight and obese children and adults have increased rapidly in both developed and developing countries, such as China. The World Health Organization reports that today, there are more people suffering from problems related to overweight and obesity than from malnutrition. Being overweight is correlated with increased morbidity and mortality, including a variety of non-communicable diseases, such as Type II diabetes, coronary heart disease and hypertension. Excess body mass not only reduces the quality of the overweight individual's personal life, it is a burden on the public social and health care systems and entails economic losses.

Leaving genetics aside, obesity is the result of energy intakes in excess of energy expenditures. As obesity is now recognized as a public health crisis, the magnitude of this modern epidemic has prompted a surge in research efforts that attempt to understand the link between different factors and obesity. Information on the social, economic, and public policy factors that contribute to obesity is emerging. Urbanization, greater inactivity and increased availability of energy-dense foods are a few of the factors identified in the literature as promoting the increase in overweight populations. While most of these factors are prominent in the rapid modernization of China, little research has been undertaken on China.

China has been experiencing tremendous changes during last three decades. While under-nutrition has long been targeted by government food policy in China, overweight and obesity are becoming a rising concern in China especially in urban areas. China's one-

child policy has inadvertently promoted the development of the "little king" concept in Chinese households, characterized by children's snacking and consumption of high-protein meals previously deemed luxuries and by requiring less physical house work. Children spend more time watching TV, playing video games, and surfing the internet. Consequently, children in China now are more at risk at becoming overweight than previous generations. Although pediatric obesity in China is less prevalent than in some developed countries, its rate is growing rapidly and portends a significant future economic and social burden.

This study explores the socioeconomic factors contributing to weight problems among children in China. We examine the influence on body mass of key factors often targeted for public policy action: fast/convenience food consumption, exposure to television, and participation in physical activities. In addition, we analyze the impacts of parents' dietary knowledge, self perception, and other demographic and lifestyle variables on children's obesity.

There are very few studies on China's childhood obesity and among the few studies on China's childhood obesity, most focus only on physical activity/inactivity and snacking. For example, a recent study by Monda and Popkin (2005) analyzed the effects of physical activity and inactivity on childhood overweight in China. Another study by Waller, Du, and Popkin (2003) examined patterns of inactivity and snacking and their relationship with overweight status in Chinese children.

To the authors' knowledge, our study is the first to examine the influence of such an extensive range of socioeconomic factors on child obesity in China. We consider aspects that have specific policy relevance, including exposure to advertising or access by

children to convenience/fast food, promoting physical activity. The results provide valuable evidence and information regarding the importance of public policy measures that might be employed and increase understanding of the importance of healthy diets in China.

The paper proceeds as follows. First, we describe the data source and chosen socioeconomic variables in detail. Second, an estimation method, the binary probit model is described, which leads to the estimation results and analysis. The final section concludes with a brief discussion.

Data

The data employed in this study come from the 2004 China Health and Nutrition Survey (CHNS), a large longitudinal data set collected by the Chinese Center for Disease Control. The data have detailed information on household and individual economic, demographic, and social factors as well as measures of health outcomes, such as height, weight, activities of daily living, and disease history, etc. The sampling population is drawn from the provinces of Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong. A multistage, random cluster process was used to draw the sample surveyed in each of the provinces. Counties in the 9 provinces were stratified by income (low, middle, and high) and a weighted sampling scheme was used to randomly select 4 counties in each province. The sample is diverse with variation found in a wide-ranging set of socioeconomic factors (income, employment, education and modernization) and other related health, nutritional and demographic measures. In addition, the provincial capital and a lower income city were selected when feasible. In two provinces, other large cities rather than provincial capitals were selected. Villages and townships within the counties

and urban and suburban neighborhoods within the cities were selected randomly. In the 2004 survey, there are 216 primary sampling units: 36 urban neighborhoods, 36 suburban neighborhoods, 36 towns and 108 villages.

Our study focuses on children aged 6 to 18 years old who live in urban areas. We separate children into two groups: ages 6 to 11 and ages 12 to 18. We isolate adolescents from younger children because teenagers have a greater degree of independence and control over their food intake, a greater capacity to understand the importance of healthy diets, and, perhaps, a greater concern for their appearance than do younger children.

The survey data had 2,324 observations for the sample of children. Our data set for children age 6 to 18 living in urban areas contained 455 observations. Time spent on physical activities included time spent on active physical activities (such as martial arts, gymnastics, dancing, acrobatics, track and field, swimming, soccer, basketball, volleyball, badminton, ping pong, etc) which were not taken in school, and physical exercises taken in class or at recess. As children in school also spent time on transportation to and from school, we took the time spent in walking and bicycling to and from school as time spent in physical activity. Time spent in sedentary activities was measured by time spent watching TV, videotapes and VCDs/DVDs, playing video or computer games, surfing the internet, doing homework, extracurricular reading, and playing toy cars, puppets, board games, etc. It was measured by minutes/week. Soft drink and sugared fruit drink consumption included consumption of both Chinese and non-Chinese brand soft drinks as well as sugared fruit drinks such as lemonade, and juices with no more than 10% fruit juice.

The body mass index (BMI) is commonly used to measure obesity, and is defined as the ratio of weight to height square in metric units [weight(kg)/height(m)^2].

Some researchers indicate that the World Health Organization's definitions of overweight (BMI>25) and obesity (BMI>30) may underestimate the true burden of the condition (Wu) as the cut-off points are derived from white populations and hence may not be applicable to other populations. Therefore, we used the cut-off points established by the Group of China Obesity Task Force (GCOTF) which is based on a reference population of more than 244 thousand elementary and secondary Han students. With 85^{th} and 95^{th} of BMI percentiles defined as overweight and obesity, respectively, the cut-off points for different sex and age groups were established (see Table 1; GCOTF). As the BMI index established by GCOTF starts only from age 7, we extrapolate it to age 6 based on the differences between the age groups. In comparison to other, international standards such as the one set by World Health Organization, the cut-off points for Chinese boys and girls set up by GCOTF are lower.

Descriptive statistics for BMI, overweight, and obesity are listed in Table 2. In total, nearly 17% (16.9%) of children are overweight (which included obesity) and 8.1% are obese in our data set; by gender, 17% of boys and 16.8% of girls are overweight; 7.4% of boys and 8.9% of girls are obese. The classification of children as overweight and obesity indicate greater problems for children in the age group of 6-11 years old. For this age group, the proportion of overweight and obesity children indicate 26% are overweight and 14.1% are obese. This is in comparison to 11.1% overweight and 4.3% obese in the age group of 12-18 year olds. Because of the small percentage of the study population in the obese category, only the overweight category, defined as BMI greater than the 85^{th} percentile, is studied.

Dietary knowledge of parents is one factor that may affect children's BMI, and related overweight and obesity status. In this study, dietary knowledge of parents was evaluated based on answers to 12 questions (please see Table 3 for details). To reduce the dimensionality of variables and also to retain the characteristics of the data that contribute most to its variance, we conducted a principal component analysis on response to the dietary knowledge questions for both father and mother. Based on the eigenvalue, only one factor was retained for both the father and mother data set. The variance explained by the retained factor was 7.5 and 9.7 for the mother and father data set, respectively.

Other variables included as the explanatory variables are family income, TV time, BMI of parents, snacking, beverage consumption, fast food consumption, and other demographic and regional variables. In addition, variables indicating dietary knowledge and self perception are included in the analysis of adolescent BMI. Careful selection of variables allows evaluation of and testing the effects of contributing factors such as the importance of television, fast food, sweetened beverage consumption, and activity levels.

Table 3 listed descriptive statistics of some major variables that we use in the empirical study.

Methodology and Empirical Results

We use the BMI as our dependent variable in a regression on an array of variables including BMI of parents, dietary knowledge of parents, time spent on physical activity and physical inactivity, snacking, beverage consumption, fast food consumption, and other demographic and regional variables. In addition, variables indicating dietary knowledge and self perception are included in the analysis of the adolescent's BMI.

A binary probit model is used to examine the influences of the factors discussed above on underweight/normal/overweight/obese categorizations. The model is set up as a

$$y^* = x'\beta + \varepsilon,\ \varepsilon \sim N(0,1)$$
$$y = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

Where y^* is a latent variable and y is a binary variable which indicates if the individual is overweight/obese or not. It can be written as

$$\Pr ob(y = 1 \mid x) = \int_{-\infty}^{x'\beta} \phi(t)dt = \Phi(x'\beta),$$

where Φ(.) is a notation for the standard normal distribution.

The probit model was run on three groups of data: the total data set for children, the data set for children aged between 6-11 years old, and the data set for children aged between 12-18 years old. As discussed above, we isolate adolescents from younger children because teenagers have a greater degree independence and control over their food intake, a greater capacity to understand the importance of healthy diets, and, perhaps, a greater concern for their appearance than do younger children.

The model was estimated by using maximum likelihood method. The estimation results for the whole data set are reported in Table 4. The estimation results show that gender does not make a significant difference on the probability of being overweight. But if the father or mother is overweight, which is indicated by his (her) BMI index, the chance of the child being overweight is much higher than when the parents are not overweight. This result is consistent with many studies, such as those by Zeller et al. who show a positive correlation between parent's and child's BMI. In contrast to some other studies that find household income to have a significant impact on children being overweight (e.g.

Strauss and Knight), we do not find a statistically significant effect of household income affecting the odds of being overweight.

Time in sedentary activity does not affect the probability of being overweight. Although this result seems to contradict most studies on U.S. children, some studies on childhood obesity in other countries have found similar results. As Waller, Du, and Popkin point out, a country like China has a very low level of inactivity overall. Hence, observed inactivity does not have the same effect on levels of overweight as are found in the U.S. Time spent on sedentary activity (including TV watching) was just roughly 4 hours a week on average or less than 1 hour a day in our dataset. Overweight does not seem to be associated with 1 hour or less per day of inactivity in any of the countries that have been studied (e.g., Waller, Du, and Popkin; Epstein et al.; Hernandez et al.). However, our results do show that snacking while watching TV or having a TV in the bedroom do significantly increase the odds of being overweight, findings which are consistent with those in the U.S. (Adachi Mejia, et al.) In addition, restrictions on watching TV reduce the odds of being overweight; buying food or drink shown on commercial TV increase the odds of being overweight. All these results suggest that TV does have a significant effect on children's overweight/obesity in China.

Among other factors, the parents' dietary knowledge is a significant factor affecting children's overweight status. The more knowledgeable parents are on diet, the less likely their children are to be overweight. Interestingly, soft drink consumption and eating western fast food did not significantly increase the odds of being overweight. This may not be surprising as the consumption of soft drink and western fast food is very limited in the regions surveyed. Our results, however, do not show significant regional variation across

the eight sample regions. Age, sleep time, and care about being liked by friends do have significant negative effects on being overweight, results which were also expected and consistent with previous studies.

The estimation results for two age groups, the younger children and the teenage group, are presented in Tables 5 and 6. Parents' BMI indices, the child's age, and sleep hours, are all significant in explaining children's overweight/obesity and show similar effects for the two age groups. In contrast, variables that reflect more controllable personal behavior are found to influence the children's overweight significantly in the teenage group, but not for younger children. For the younger children, parents' dietary knowledge is significant, although this variable is not statistically significant in adolescent's group. Although TV watching has a significant effect in both groups, different TV variables are statistically significant. Having snacks while watching TV increased the odds of being overweight for younger children while buying food or drink shown on TV commercials, having a TV in bedroom, and having restrictions on watching TV have significant effects on the adolescents' possibility of being overweight. These results suggest that while controlling TV activity does influence children's probability of being overweight, different restrictions may apply to different age groups.

Dining in western fast food restaurants, and being concerned about being liked by friends have significant effects on the probability of being overweight in the adolescent group; parents' dietary knowledge did not. These effects are in contrast to the effects of those variables on the younger children's group. As observed in other countries and cultures, as the children grow up, they are less influenced by their parents; instead, the

resulting overweight is determined more by their own behaviors. In the adolescent group, the probability of being overweight does vary over regions (Table 6).

Conclusions

Using a large longitudinal China survey data set, this study provides an assessment of the influence of socioeconomic and other factors on the prevalence of overweight/obesity among urban children in China. We are the first to do so. As China's population ages, the health condition of the generation of one-child households is crucial to China's future economic growth and social wellbeing. The results from this study provide important information for policymakers as they consider options for taking an active role in stemming the growth in overweight/obesity in China. From the probit regression analysis, we find that parents' BMI indices, child age, sleep time, parents' diet knowledge, and other personal lifestyle variables such as TV watching, TV commercials, restrictions on the time of watching TV, and snacking while watching TV are all significant factors that influence the children's overweight/obesity. Improving nutrition education for parents, or restricting TV access or TV commercials aimed at children are some public actions that may be possible to reduce the overweight problem among children.

When we divide the data set by children's age to younger children and the teenage group, we find quite different patterns explain children's overweight status. For younger children, parents' dietary knowledge is significant, in comparison to variables reflecting more controllable personal lifestyle behavior that are found to influence the children's BMI significantly in teenage group. For the adolescents, nutrition education oriented by

perceptions by others would be more effective in this age group. Different controls and policies may apply to different age groups.

Our research suggests the need for future research in the following areas. First, we note that children's sedentary activity may be endogenously determined by their BMI. That is, overweight children may be more reluctant to participate in physical activities. Explicitly accounting for such endogeneity would improve the accuracy of our estimation results. Second, it is possible to analyze sample regions individually to further investigate the overweight patterns after accounting for regional characteristics. Our behavioral evidence suggests that regional factors may influence overweight status, especially for the adolescent group. Finally, there are other more complicated estimation techniques such as mixed logit/probit regression method and Bayesian methods. Further investigation by employing such advanced methods may help us further exploit the richness of the data and to better understand the determinants of the overweight problem in China.

Table 1. Cut-off Points for BMI for Overweight and Obesity by Sex between 6 and 18 years.

	boy		girl	
age	overweight	obesity	overweight	obesity
6	16.7	18.1	16.3	17.9
7	17.4	19.2	17.2	18.9
8	18.1	20.3	18.1	19.9
9	18.9	21.4	19.0	21.0
10	19.6	22.5	20.0	22.1
11	20.3	23.6	21.1	23.3
12	21.0	24.7	21.9	24.5
13	21.9	25.7	22.6	25.6
14	22.6	26.4	23.0	26.3
15	23.1	26.9	23.4	26.9
16	23.5	27.4	23.7	27.4
17	23.8	27.8	23.8	27.7
18	24.0	28.0	24.0	28.0

From Group of China Obesity Task Force. Standards for age 6 are derived from the difference between other age groups.

Table 2. Descriptive Statistics for Measures of Obesity and Overweight

Variable	N	Mean	Std Dev	Minimum	Maximum
Total					
bmi	455	18.8296	4.4158	8.3330	50
Overweight (%)	455	0.1692	0.3754	0	1
Obesity (%)	455	0.0813	0.2736	0	1
Boys					
bmi	229	19.1125	4.5158	11.9936	50.0000
Overweight (%)	229	0.1703	0.3767	0.0000	1.0000
Obesity (%)	229	0.0742	0.2627	0.0000	1.0000
Girls					
bmi	226	18.5429	4.3032	8.3330	41.7655
Overweight (%)	226	0.1681	0.3748	0.0000	1.0000
Obesity (%)	226	0.0885	0.2846	0.0000	1.0000
Children aged 12-18					
bmi	278	19.8696	4.1037	13.7442	50.0000
Overweight (%)	278	0.1115	0.3153	0.0000	1.0000
Obesity (%)	278	0.0432	0.2036	0.0000	1.0000
Children aged 6-11					
bmi	177	17.1962	4.4049	8.3330	41.7655
Overweight (%)	177	0.2599	0.4398	0.0000	1.0000
Obesity (%)	177	0.1412	0.3493	0.0000	1.0000

Table 3. Survey Questions on Parent's Dietary Knowledge

1. Choosing a diet with a lot of fresh fruits and vegetables is good for one's health
2. eating a lot of sugar is good for one's health
3. eating a variety of foods is good for one's health
4. choosing a diet high in fat is good for one's health
5. choosing a diet with a lot of staple foods (rice and rice products and wheat and wheat products) is not good for one's health
6. consuming a lot of animal products daily (fish, poultry, eggs and lean meat) is good for one's health
7. reducing the amount of fatty meat and animal fat in the diet is good for one's health
8. consuming milk and dairy products is good for one's health
9. consuming beans and bean products is good for one's health
10. physical activities are good for one's health
11. sweaty sports or other intense physical activities are not good for one's health
12. the heavier one's body is, the healthier he or she is

Table 4. Probit Model Parameter Estimates for Children of All Ages

Parameters	estimates	Standard errors	Pr>chi square
Intercept**	-2.5339	1.0231	0.0133
Male	0.1422	0.1943	0.4642
Father's BMI***	0.1479	0.0333	<.0001
Mother's BMI**	0.056	0.0233	0.0161
Household income	0	0	0.7591
Sedentary activity	0.0002	0.0006	0.7518
Age***	-0.1199	0.0349	0.0006
Sleep time (hours)***	-0.1918	0.0606	0.0015
Eating snacks while watching TV*	0.3568	0.1892	0.0593
Watch TV when eating meal	-0.0075	0.1481	0.9599
Buying food or drinks shown on TV commercials*	0.2476	0.127	0.0512
Having a TV in bedroom**	0.5497	0.2602	0.0346
Care about being liked by friends*	-0.2485	0.1501	0.098
Parent's diet knowledge*	-0.2	0.1065	0.0604
Soft drink consumption	-0.0722	0.0776	0.352
Restrictions on how long for watching TV**	-0.3137	0.1334	0.0187
Numbers of dining in western fast food restaurant in the last 3 months	-0.0227	0.0511	0.657
Liaoning	-0.4417	0.4413	0.3168
Heilongjiang	-0.4199	0.3837	0.2738
Jiangsu	-0.3433	0.3992	0.3898
Shandong	0.0782	0.4718	0.8684
Henan	-0.2322	0.4302	0.5895
Hubei	-0.1801	0.4419	0.6836
Hunan	-0.3922	0.4701	0.404
Guangxi	-0.4687	0.3748	0.2111

Table 5. Probit Model Parameter Estimates for Younger Children (ages 6-11)

parameters	estimates	Standard errors	Pr>chi square
Intercept	-3.9845	3.3876	0.2395
male	0.1823	0.3056	0.5508
Father's BMI***	0.1616	0.0516	0.0018
Mother's BMI	0.0056	0.0371	0.8796
Household income	0	0	0.2023
Sedentary activity	0.003	0.0015	0.0391
Age**	-0.2088	0.1039	0.0446
Sleep time (hours)**	-0.2455	0.0998	0.0139
Eating snacks while watching TV**	0.4599	0.3502	0.1891
Watch TV when eating meal	-0.0487	0.2511	0.8464
Buying food or drinks shown on TV commercials	-0.0139	0.214	0.9481
Having a TV in bedroom	0.4128	0.4989	0.4079
Care about being liked by friends	1.5139	1.8649	0.4169
Parent's diet knowledge*	-0.2246	0.128	0.0795
Soft drink consumption	-0.1788	0.1128	0.1128
Restrictions on how long for watching TV	-0.1642	0.2404	0.4945
Numbers of dining in western fast food restaurant in the last 3 months	0.0654	0.0771	0.3961
Liaoning	-0.5044	0.6716	0.4527
Heilongjiang	-0.4067	0.5796	0.4829
Jiangsu	-0.6963	0.64	0.2766
Shandong	0.4769	0.7201	0.5078
Henan	-0.3326	0.7113	0.6401
Hubei	-0.9272	0.821	0.2588
Hunan	-0.3413	0.8522	0.6888
Guangxi	-0.1501	0.5516	0.7855

Table 6. Probit Model Parameter Estimates for Teenagers (ages 12-18)

parameters	estimates	Standard errors	Pr>chi square
Intercept***	-8.8716	2.4978	0.0004
male	-0.0232	0.3255	0.9432
Father's BMI***	0.1693	0.056	0.0025
Mother's BMI***	0.1281	0.0417	0.0021
Household income	0	0	0.3405
Sedentary activity	-0.0005	0.001	0.6562
Age*	0.1853	0.1063	0.0813
Sleep time (hours)*	-0.1826	0.0987	0.0643
Eating snacks while watching TV	0.4787	0.304	0.1153
Watch TV when eating meal	-0.0704	0.2209	0.75
Buying food or drinks shown on TV commercials*	0.4064	0.2191	0.0636
Having a TV in bedroom*	0.749	0.411	0.0684
Care about being liked by friends*	-0.3482	0.1854	0.0604
Parent's diet knowledge	-0.6179	0.4063	0.1283
Soft drink consumption	0.1143	0.135	0.3973
Restrictions on how long for watching TV*	-0.3805	0.2253	0.0912
Numbers of dining in western fast food restaurant in the last 3 months**	-0.2176	0.0979	0.0263
Liaoning**	-1.6763	0.8135	0.0393
Heilongjiang**	-1.844	0.7912	0.0198
Jiangsu	-0.4855	0.6252	0.4375
Shandong	-0.8911	0.8153	0.2744
Henan	-0.6794	0.6258	0.2776
Hubei	-0.7283	0.6887	0.2903
Hunan*	-1.3756	0.8316	0.0981
Guangxi*	-1.1045	0.5874	0.0601

Reference

Adachi-Mejia, A., M. Longacre, J. Gibson, M. Beach, L. Titus-Ernstoff, and M. Dalton. "Children with a TV in Their Bedroom at Higher Risk for Being Overweight." *International Journal of Obesity* 31 (2007): 644-51.

Delmas, C., C. Platat, B. Schweitzer, A. Wagner, M. Oujaa, and C. Simon. "Association Between Television in Bedroom and Adiposity Throughout Adolescence." *OBESITY* 15 (2007): 2495-2503.

Epstein, L., R. Paluch, C. Gordy, and J. Dorn. "Decreasing Sedentary Behaviors in Treating Pediatric Obesity." *Arch Pediatr Adolesc Med*. 154 (2000): 220-6.

Group of China Obesity Task Force. "Body Mass Index Reference Norm for Screening Overweight and Obesity in Chinese Children and Adolescents." *Chin J Epidemiol* 25(2004): 97-102.

Hernandez, B., S. Gortmaker, G. Colditz, K. Peterson, N. Laird, and S. Parra-Cabrera. "Association of Obesity with Physical Activity, Television Programs and Other Forms of Video Viewing Among Children in Mexico City." *Int J Obes Relat Metab Disord* 14 (1999): 845-54.

Monda, K. and B. Popkin. "Cluster Analysis Methods Help to Clarify the Activity-BMI Relationship of Chinese Youth." *Obesity Research* 13 (2005):1042-51.

Strauss, R. S. and J. Knight. "Influence of the Home Environment on the Development of Obesity in Children." *Pediatrics* 103 (1999):e85.

Waller, C.E., S. Du, and B. M. Popkin. "Patterns of Overweight, Inactivity, and Snacking in Chinese Children." *Obesity Research* 11 (2003):957-961.

Wu, Y. "Overweight and Obesity in China."

Zeller, M., J. Reiter-Purtill, A. Modi, J. Gutzwiller, K. Vannatta, and W. Davies. "Controlled Study of Critical Parent and Family Factors in the Obesigenic Environment." *OBESITY* 15 (2007):126-136.