Socioeconomic Status and Obesity Gradient over Age: New Evidence from China

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Abstract: This paper presents a systematic analysis of the impact of socioeconomic status (SES) on overweight and obesity in China and investigates how and why the SES-obesity gradient differs with age. Using a longitudinal sample drawn from the China Health and Nutrition Survey (CHNS), I find that body mass index (BMI) is positively associated with SES during early childhood but becomes inversely related to childhood SES as children age into adulthood. Estimation results show that children from low SES families are less likely to be overweight or obese than their median and high SES peers. The results from subsamples stratified by living area reveal that the SES gaps of obesity are generally larger for urban residents than rural residents. Females are significantly less likely to be overweight than males in China. The SES during childhood has independent effects after controlling for respondents' contemporaneous SES. The relationship between the contemporaneous SES of a male adult and his chance of being overweight or obese is significantly positive, while the contemporaneous SES of a female adult is negatively related to her chance of being overweight or obese.

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1. Introduction

Emerging as a global epidemic, obesity has been recognized as a serious public health issue in both industrialized and developing countries due to its chronic health implications. China, the world's most populous country, has witnessed a dramatic increase in the prevalence of overweight and obesity over the past two decades of impressive economic development.[1] Using the data from the 2002 China National Nutrition and Health Survey, Wu et al. (2005) reported that 14.7% of Chinese were overweight and another 2.6% were obese, implying about 184 million overweight people, and 31 million obese people in China in 2002, out of a total population of 1.3 billion. Some recent studies, predominately published in Chinese journals, indicate that the prevalence of obesity is fast catching up with the developed countries such as the United States.[2] While it is alarming that about one fifth of the one billion currently overweight or obese people in the world are Chinese,[3] few studies have investigated the factors that are correlated with this. The main objective of this paper is to investigate one such potential factor--socioeconomic status (SES)--and study how and why the SES-obesity gradient differs with age.

Numerous studies have investigated the positive association between socioeconomic status and health. Some of these studies have focused on the family income gradient in children's health. For example, Case et al. (2002) examined the way that relationship between SES and health changes with age among children. They showed that the well-known cross-sectional relationship between SES and health exists in childhood and is more pronounced among older, rather than young children. Meanwhile, other studies have

[1] See, for example, Wang et al. (2007) and Zhao et al. (2008).
[2] See, for example, Li et al. (2005).
[3] See WHO-MONICA project (1989).

focused on obesity growth with age. Baum and Ruhm (2009) investigated how body weight and obesity change with age for a cohort moving through middle adulthood in the US, although their results, based on the self-reported height and weight data, may suffer from measurement errors bias. The lack of the childhood data also limits the age profile of SES-obesity gradients for young children within the literature. However, there is also a vast amount of work documenting that poor health in childhood affects adult health and SES through multiple pathways. Currie and Stabile (2003) found that the health of low-SES children worsens with age because they are subject to more shocks.

Although there is an expanding body of literature examining the relationship between SES factors and obesity for overweight and obese adults, less research has included the younger cohort. Children's obesity rates in China have skyrocketed in the past two decades. Ji et al. (2004) found that the prevalence of overweight and obesity in children aged 7-18 years increased 28 times and obesity increased four times between 1985 and 2000. These alarming trends start to receive a great deal of attentions recently because growing evidence shows that childhood obesity has a profound influence on morbidity and mortality in adult life.

In this paper, I present a systematic analysis of the impact of socioeconomic status (SES) on overweight and obesity in China, investigate how the SES-obesity gradient differs with age, and study the channels for these SES-disparities from early childhood to middle adulthood. Moreover, it is argued that how SES and obesity are related among adults remains elusive. It is likely that the causality operates in either direction. I nevertheless expect that it may be easier to disentangle the issue of the causality among children because

SES is mainly determined by parental characteristics instead of being influenced by their own obesity status and the related social consequences.

Many previous studies use cross-sectional data to document that the connection between SES and weight that strengthens over time. However, since such data provide only contemporaneous information, it is hard to study how SES in earlier life is related to adult obesity. Using a longitudinal sample drawn from the China Health and Nutrition Survey (CHNS), this paper presents a dynamic description of the impact of SES on overweight and obesity status in China, as well as both how the SES-obesity gradient differs with age and channels for these SES-disparities. The estimation results find that the average body mass index (BMI) increases with age and is positively associated with SES during childhood. It becomes inversely related to childhood SES after growing up, which is consistent with research on the economics of obesity for adults from western countries. I also find that the SES-obesity gradient rotates most for the low SES cohorts. However, I do not find that higher childhood SES is associated with a higher chance of overweight and obesity, as found in the literature using developed country data. Instead, I find that children from low SES families are less likely to be overweight or obese than their median and high SES peers, which is consistent with research on Chinese obesity (Wang, 2001). The results from subsamples stratified by living areas (rural vs. urban) reveal that the SES gaps of overweight and obesity are generally larger for urban residents than rural residents.

This study indicates that females are significantly less likely to be overweight or obese than males in China. The SES during childhood has independent effects after controlling for respondent adult SES. Interestingly, there is a significantly positive relationship between the adult SES of a man and his chance of becoming overweight or obese. In this instance, early

childhood SES becomes insignificant. On the contrary, the adult SES of a woman is negatively related with her chance of being overweight or obese.

The rest of the paper proceeds as follows: Section II describes an overview of the data. Section III presents an econometric model. Section IV explains estimation methods. Results appear in Section V, followed by concluding remarks in Section VI.

2. Data and Summary Statistics

The data used in this study are drawn from the China Health and Nutrition Survey (CHNS).[4] These surveys were initially conducted by the Carolina Population Center at the University of North Carolina, Chapel Hill, the Institute of Nutrition and Food Hygiene, and the Chinese Academy of Preventive Medicine in 1989. Six more waves of panel surveys were conducted in 1991, 1993, 1997, 2000, 2004, and 2006 respectively. The 1989 survey included 3,795 households and 15,917 individuals. A multi-stage, random cluster sampling design was used to draw the sample from eight provinces—Guangxi, Guizhou, Henan, Hunan, Jiangsu, Liaoning and Shandong.[5] These provinces vary substantially in geography, economic development, public resources, and health indicators. The CHNS has collected a wide range of information on households, community, economic, and health and nutrition, family panning facilities. Physical activities surveys contain detailed information on health status measurements such as weight, height, arm and head circumference and mid-arm skin fold measurements.

[4] Data and documentation for the CHNS are available as public-use data sets from the Inter-university Consortium for Political and Social Research, University of Michigan.

[5] In 1997, the survey designers dropped Liaoning province and added Heilongjiang province. Liaoning province returned to the survey in 2000.

This study utilizes the 1991, 1993, 1997, 2000, 2004 and 2006 panels of the CHNS because health and nutritional data was collected only from preschoolers and adults aged 20-45 in 1989. The final sample includes observations on 4,111 individuals in 1991 households between the ages of 2 and 38. Observations with missing information were excluded, leaving a final sample of 20,104 person-year observations.

Weight and height measurements were collected for all survey participants by trained health workers who followed standard protocol and techniques. Height was measured without shoes to the nearest tenth of a centimeter with a portable stadiometer. Weight was measured in light indoor clothing without shoes to the nearest tenth of a kilogram with a balance beam scale. Each of these measurements was taken by at least two health workers. One worker took the measurement, and the other recorded the readings.

Body Mass Index (BMI), measured by weight (kg)/height^2 (m^2), is used to delineate overweight and obesity. In China, the most commonly used weight classifications for adults come from the WHO standard (World Health Organization, 2000) and the recently developed Chinese standard with lower BMI cutoff points (Wang et al. 2007).[6] Since it is argued that the WHO BMI cutoff points are developed primarily based on data collected from developed countries, the Cooperative Meta-Analysis Group of the Working Group on Obesity in China developed the Chinese standard based on analysis of data collected from 239,972 Chinese adults in the 1990s (Zhou, 2002). In this population, a BMI of 24 kg/ m^2 was found to have the best sensitivity and specificity for identifying risk factors, including hypertension, diabetes, and dyslipidaemia. There is a growing body of evidence that people in China as well as some other Asian Pacific populations have an elevated risk for obesity-

[6] A detailed classification of overweight and obesity table is attached in the Appendix.

related diseases at a lower BMI than Caucasians (Zhou, 2002; Misra, 2003; and WHO, 2004). I take an agnostic view about which criteria are the "best" and present the results using both categorization methods. Following WHO's recommendation, the more complicated gender- and age-specific growth charts with BMI cut-offs compiled by the Center for Disease Control and Prevention (Kuczmarski et al. 2000) are used to define overweight and obesity for persons under 21 years old. Children with a BMI above the age- and sex- specific 95th percentile of the BMI growth chart are classified as "obese". Those with a BMI between the age- and sex- specific 85th and 95th percentile are classified as "overweight".

Table 1. Descriptive statistics by gender, living area and SES

Variable	Full Sample	Gender		Living Area		Maternal Education		
		Male	Female	Rural	Urban	Low	Medium	High
BMI	18.01	18.20	17.79	17.90	18.29	18.37	17.46	17.71
	(0.03)	(0.03)	(0.04)	(0.03)	(0.05)	(0.03)	(0.05)	(0.07)
Age	12.61	13.08	12.05	12.50	12.90	14.10	10.60	10.80
	(0.05)	(0.07)	(0.06)	(0.06)	(0.09)	(0.07)	(0.08)	(0.10)
Obese (%)	4.84	5.63	3.88	4.68	5.25	3.78	6.25	6.17
	(0.15)	(0.22)	(0.20)	(0.18)	(0.30)	(0.18)	(0.32)	(0.44)
Overweight (%)	6.78	7.39	6.05	6.26	8.14	6.29	7.07	8.12
	(0.18)	(0.25)	(0.25)	(0.20)	(0.36)	(0.23)	(0.34)	(0.50)
Overweight/obese (%)	11.62	13.03	9.94	10.94	13.39	10.07	13.32	14.29
	(0.23)	(0.32)	(0.31)	(0.26)	(0.45)	(0.28)	(0.45)	(0.63)
Male (%)	54.65	---	---	55.58	52.24	55.34	53.98	53.28
	(0.35)			(0.41)	(0.67)	(0.47)	(0.66)	(0.91)
Rural (%)	71.95	73.18	70.47	---	---	79.36	68.12	51.30
	(0.32)	(0.42)	(0.48)			(0.38)	(0.62)	(0.91)
Number of children in household	1.51	1.41	1.63	1.61	1.25	1.55	1.52	1.34
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Mother's education (years)	8.10	8.09	8.10	7.76	8.86	6.41	8.20	10.51
	(0.05)	(0.07)	(0.08)	(0.05)	(0.11)	(0.06)	(0.05)	(0.11)
Household income (RMB)	15,103	15,352	14,808	13,332	19,625	13,232	16,126	20,113
	(123)	(183)	(158)	(133)	(264)	(159)	(210)	(370)
Ever smoked (%)	6.76	12.20	0.22	6.86	6.53	9.83	3.04	2.24
	(0.18)	(0.31)	(0.05)	(0.21)	(0.33)	(0.28)	(0.23)	(0.27)
Current smoker (%)	6.46	11.68	0.18	6.57	6.19	9.40	2.89	2.11
	(0.17)	(0.31)	(0.04)	(0.201)	(0.32)	(0.27)	(0.22)	(0.26)

Bus (%)	6.16	5.97	6.41	3.18	12.75	4.31	6.03	10.50
	(0.29)	(0.38)	(0.44)	(0.25)	(0.71)	(0.36)	(0.48)	(0.81)
Bike (%)	23.46	23.66	23.19	22.51	25.57	21.70	23.52	27.81
	(0.61)	(0.81)	(0.93)	(0.72)	(1.13)	(0.85)	(1.09)	(1.46)
Number of observation	20104	10986	9118	14465	5639	11389	5684	3031

Note: (1) Data source: China Health and Nutrition Survey (1991, 1993, 1997, 2000, 2004 and 2006). (2)Standard errors are shown in parentheses. (3) Information on BMI, obesity and overweight are calculated using the weight and height measurements by health professionals following the criteria created by the Working Group on Obesity in China. (4) Maternal education is low for respondents whose mothers has completed primary school or less, medium for lower middle school, high for upper middle school, technical or vocational degree, and college degree and above. (5) Household income is inflated to 2006-year Chinese Yuan (RMB).

Table 1 reports means for the main variables used in the analysis. Average age and maternal education are similar for males and females, although about 13% of males but only about 10% of females were either overweight or obese. Males also have higher household income and higher rates of smoking. 'Urban areas' refers to cities and town inhabited by people not engaged in farm work. 'Rural areas' refer to villages where farmers live but not cities or towns. In China, people living in urban areas usually have better living standard, higher income and education, and better retirement benefits and health care services than those living in rural areas. The rural and urban differences are very pronounced in many respects in China. Urban residents are heavier, earn higher income, have higher rates of obesity and overweight. No significant difference is found in smoking rates. The last three columns in Table 1 present the summary statistics of the key variables by different maternal education levels. Maternal education is low for respondents whose mothers has completed primary school or less, medium for lower middle school, and high maternal education includes upper middle school, technical or vocational degree, or college degree and above. In contrast to the reverse relationship between SES and obesity shown in the literature,[7] higher maternal education level is associated with greater chance of being overweight or

[7] See, for example, Case et al. (2002) and Anderson et al. (2003).

obese. The SES difference with respect to the obesity and overweight prevalence is extremely evident between low and medium-to-high SES individuals. Compared to less advantaged individuals, respondents with medium and highly educated mothers are more often obese or overweight, although they tend to smoke less.

Table 2. Overweight and obesity prevalence by survey year

	BMI		WHO Reference				China Reference			
			Overweight (%)		Obesity (%)		Overweight (%)		Obesity (%)	
	1991	2006	1991	2006	1991	2006	1991	2006	1991	2006
Full Sample	17.23	19.43	4.90	9.42	3.65	7.56	4.96	10.37	3.65	8.23
	(0.05)	(0.10)	(0.34)	(0.64)	(0.29)	(0.58)	(0.34)	(0.67)	(0.30)	(0.60)
Males	17.11	19.99	4.25	11.92	4.34	8.27	4.30	12.88	4.35	9.38
	(0.06)	(0.13)	(0.44)	(0.91)	(0.44)	(0.78)	(0.44)	(0.95)	(0.44)	(0.82)
Females	17.36	18.62	5.56	5.69	3.00	6.52	5.66	6.64	2.91	6.52
	(0.07)	(0.15)	(0.51)	(0.80)	(0.38)	(0.85)	(0.52)	(0.86)	(0.38)	(0.85)
Low maternal education	17.74	19.77	4.20	9.45	3.13	5.00	4.30	10.80	3.13	6.00
	(0.06)	(0.15)	(0.38)	(0.98)	(0.33)	(0.73)	(0.39)	(0.10)	(0.33)	(7.93)
Medium maternal education	16.26	19.03	6.38	9.25	4.60	10.30	6.42	9.76	4.60	10.75
	(0.09)	(0.16)	(0.82)	(1.02)	(0.70)	(1.07)	(0.82)	(1.00)	(0.70)	(1.10)
High maternal education	16.15	19.48	6.12	9.68	4.85	8.00	6.12	10.67	4.85	8.19
	(0.11)	(0.25)	(1.10)	(1.47)	(1.00)	(1.40)	(1.10)	(1.54)	(0.99)	(1.37)

Notes: (1) Standard errors are reported in parentheses. (2) The criteria for overweight and obesity categorization for respondents whose age are less than 20-year-old are based on CDC. (3) Maternal education is categorized as 'Low Maternal Education' if the mother has ' 0-No or some primary school' or '1-graduated from primary school'; 'Medium Maternal Education' if she obtains '2-lower middle school degree', 'High Maternal Education' if she achieves '3-upper middle school degree' or '4 technical or vocational degree'; '5-university or college degree' or '6 master's degree or higher'. (4) Data is from the 1991 and 2006 years of the China Health and Nutrition Survey (CHNS).

Table 2 presents descriptive statistics for the increase in BMI and obesity prevalence from 1991 to 2006 for the CHNS cohort. The average BMI of CHNS respondents rose 13 percent (from 17.23 to 19.43 kg/m^2) between 1991 and 2006, while obesity prevalence more

than doubled from 3.65% to 7.56% (WHO criteria) and 8.23% (Chinese criteria) and the chance of being overweight increased at the similarly alarming rate as obesity from 4.9% to 9.42% (WHO criteria) and 10.37% (Chinese criteria).

In 1991, the average BMI and overweight prevalence for males and females were similar. Males became heavier and were much more likely to be overweight by 2006 (from 4.25% to 11.92%), while female overweight rates stay quite stable at about 5.6% over those 15 years. The obesity prevalence for men (women) increases from 4.34% (3%) to 8.27% (6.52%), which indicates that the chance of being obese has more than doubled over the 15 years.

The last three rows of Table 2 present how the body weight statistics change over time if the sample is stratified by early life SES, which is indexed by maternal education level. The rise of overweight prevalence is the most pronounced in the low maternal education group (from 4.2% to 9.45%), given that the overweight prevalence is very similar among different SES groups in 2006. In contrast, the rise of obesity is the most dramatic in the medium education group (from 4.6% to 10.30%). Three factors may explain this result. First, with the subsequent rapid economic development in China in the 1990s, the disadvantaged respondents in 1991 witnessed the fastest change in their lifestyle, and exhibited similar overweight prevalence to their previously advantaged counterparts. Second, as shown from the table, the obesity prevalence for those whose mothers have medium education not only increased most rapidly but also became the most likely group to be obese when compared to the most disadvantaged and advantaged. This may be due to the fact that low SES respondents are not wealthy enough to consume modern fast foods, which is still quite expensive in China, while the medium SES individuals can afford it. On the other hand, the

highest SES respondents could afford those high calorie foods, but may be well-informed that overconsumption of those foods is not healthy. Third, compared to the low SES group, medium and high SES people are more likely to reside in the highly populated urban areas where land becomes scarcer, which limit the physical education area. It also makes people rely more on the buses and taxis, instead of walking or bicycles.

3. Model of Flow of Calories and Weight Production

Cutler et al. (2003) developed a framework on weight gain through the flow of calories. When the calories consumption (I) exceeds calories expenditure (E), the body weight (W) gets heavier. Three major sources of calories expenditure includes basal metabolism (B), food processing (F) and calories burned by physical activity (P), which can be expressed as:

$$E_{it} = B_{it} + F_{it} + P_{it} \tag{1}$$

Basal metabolism is defined as the minimum energy output of the body required to sustain basic bodily functions when fasting and completely at rest, and expressed as the calories released per unit of body weight (W) plus an individual-specific component:

$$B_{it} = a_i + bW_{it} \tag{2}$$

The energy cost of basal metabolism increases if a person weighs more. For simplicity, the energy cost of food processing is assumed to be about 10 percent of total energy expenditure (Cutler et al., 2003). The calories consumption of physical activity varies with weight according to:

$$P_{it} = f_a(T) * W_{it} \tag{3}$$

where $f_a(T)$ is the exercise index indicating the sum of physical activity during time period T,

$$f_a(T) = \sum_a \gamma_a Time_a \tag{4}$$

The body weight will stay the same at time *t* if

$$I_{it} = B_{it} + F_{it} + P_{it} \tag{5}$$

or

$$W_{it} = \frac{\square 0.9 I_{it} - a_i}{b + f} \tag{6}$$

The model clearly demonstrates the possible mechanisms that may link weight with SES. If the SES of an individual has an impact on the amount of calories a person consumes, the intensity of physical activity he/she participates, and the baseline metabolism rate, he/she will end up with weight gain or loss depending on the direction of the impact. In China, especially the urban areas, if advantaged individuals have more resources to consume a greater number of calories, they will weigh more than their disadvantaged counterparts. On the other hand, if the advantaged individuals are better informed about healthy foods and dieting, the pathway will work in the opposite direction. This model allows the possibility of empirically testing how weight is related to both early life and current self-SES.

4. Empirical Strategy

The linear regression analysis will be used to explore how age and SES-obesity gradient are associated. The basic model is specified as:

$$Y_{it} = \beta_0 + \beta_1 year_{it} + \beta_2 sex_i + \beta_3 age_{it} + \beta_4 SES_i + \varepsilon_{it} \tag{7}$$

$$Y_{it} = \beta_0 + \beta_1 year_{it} + \beta_2 sex_i + \beta_3 age_{it} + \beta_4 SES_i + \varepsilon_{it}$$

where Y_{it} denotes BMI, obesity or overweight for person *i* at time *t*, $year_{it}$ is a vector of survey year dummy variables, sex_i is the gender variable, age_{it} is the age of individual *i* at

time t, SES_i denotes the early childhood socioeconomic status, and ε_{it} is the error term. More regressors, such as respondent education level, will be added in the subsequent econometric models to better understand the mechanism through which childhood SES may operate. In this basic model, the SES-gradients on weight related outcomes (β_2) are restricted to be age-invariant. This could be relaxed by estimating:

$$Y_{it} = \beta_0 + \beta_1 year_{it} + \beta_2 sex_i + \beta_3 age_{it} + \beta_4 SES_i + \beta_5 SES_i * age_{it} + \varepsilon_{it} \quad (8)$$

where β_5, the coefficient of the interaction term $SES_i * age_{it}$, estimates how SES-gradients vary with age. Furthermore, a linear model is specified to test whether the early life SES has independent effects from current SES as follows.

$$Y_{it} = \beta_0 + \beta_1 year_{it} + \beta_2 sex_i + \beta_3 age_{it} + \beta_4 SES_i + \beta_5 CurrentSES_i + \varepsilon_{it} \quad (9)$$

The models are analyzed by using the information of both early life and adult socioeconomic status from CHNS panel data. This paper further stratifies the sample by sex and urban/rural residency to discover possible different pathways for the empirical relationship between SES and overweight or obesity among diverse demographic groups in China.

5. Estimation Results

Estimates of equation (1) and (2) are presented in Tables 3a-3c, with additional covariates limited to gender and survey year.[8] Table 3a reports the estimates of age and SES gradients in BMI and obesity using trichotomous maternal education variable as the proxy

[8] The coefficients on the survey year dummies are omitted from the table results.

for respondent's early life SES. [9] Columns (1), (3) and (5) report the estimated age and SES gradients for BMI and obesity prevalence controlling for the low and medium early life SES, with the high category (high middle school and above) constituting the reference group. Columns (2), (4) and (6) include an interaction term between age and maternal education to examine how SES gradients change with age.

Table 3a. Econometric estimates of age and SES gradients in BMI and obesity- trichotomous SES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	BMI		WHO Reference Obesity Prevalence		China Reference Obesity Prevalence		Age<20	Age≥20
Age	0.286***	0.288***	-0.006***	-0.008***	-0.005***	-0.008***	-0.011***	0.000
	(0.004)	(0.010)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
Low mother education	-0.191**	-0.208	-0.000	-0.041***	-0.001	-0.042***	-0.034**	-0.034
	(0.063)	(0.134)	(0.004)	(0.009)	(0.005)	(0.060)	(0.011)	(0.082)
Median mother education	-0.194**	-0.074	-0.002	-0.016	-0.001	-0.019	-0.022	0.042
	(0.067)	(0.145)	(0.005)	(0.010)	(0.005)	(0.010)	(0.012)	(0.092)
Age* low mother education		0.001		0.004***		0.004***	0.003**	0.001
		(0.011)		(0.001)		(0.001)	(0.001)	(0.003)
Age* median mother education		-0.011		0.001		0.002	0.002	-0.002
		(0.012)		(0.001)		(0.001)	(0.001)	(0.004)
Female	-0.081	-0.079	-0.020***	-0.019***	-0.020***	-0.020***	-0.018***	-0.011*
	(0.042)	(0.042)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
_cons	15.025***	15.002***	0.139***	0.166***	0.136***	0.165***	0.173***	0.023
	(0.109)	(0.146)	(0.006)	(0.010)	(0.008)	(0.010)	(0.011)	(0.081)
R^2	0.306	0.306	0.039	0.041	0.033	0.034	0.045	0.012
N	20104	20104	20104	20104	20104	20104	17369	2735

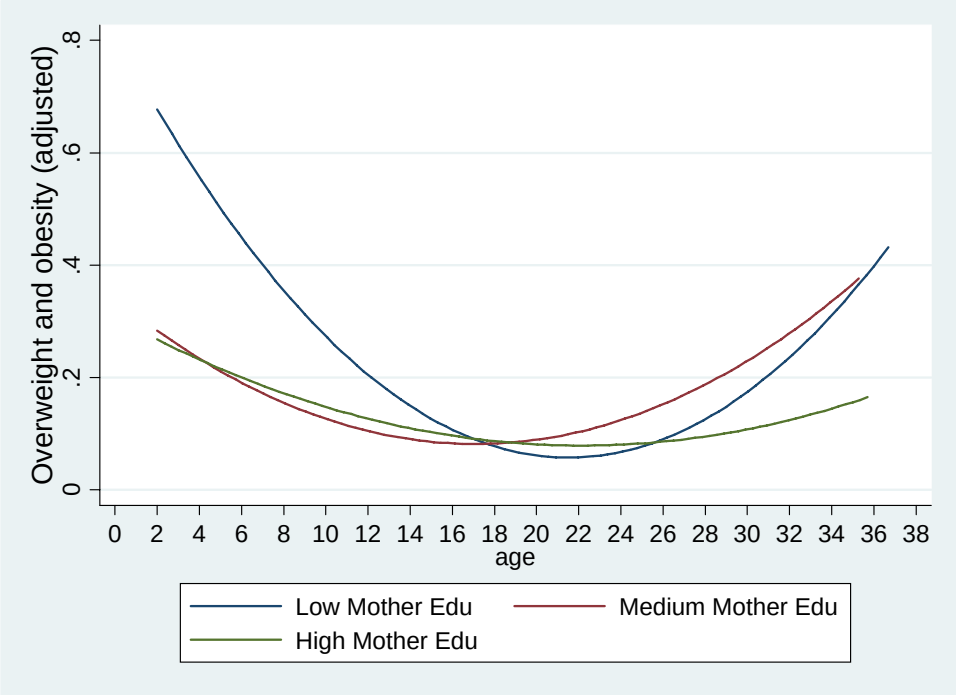
Note: Linear probability models are used to estimate the relationship between age, socioeconomic status and their interaction on obesity. Column (7) and (8) report the regressions with obesity (WHO) as dependent variable. The regressions also control survey year dummies. Standard errors are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

[9] Corresponding to the categories used in the descriptive analysis previously, maternal education is low for respondents whose mothers have completed primary school or less, medium for lower middle school, high for high middle school or above.

Columns (1), (3) and (5) of Table 3a show that BMI is predicted to increase by 0.29 kg/m^2 per year of age and low (medium) SES individuals are expected to have a BMI 0.191 (0.194) percentage point below that of high SES peers and 0.02 (0.17) percentage point less obesity prevalence. These coefficients are all statistically significant except for obesity prevalence. After adding the interaction between age and maternal education, the SES disparities initially narrow with age and eventually SES and the obesity prevalence hold a negative relationship. Specifically, the low SES group has the lowest chance of being obese when the respondent is young, but the negative difference in obesity prevalence between low and medium (high) SES groups shrinks gradually over age and becomes positive as the individual reaches about 11.1 (11.7) years old.[10] The obesity disparity between low and high SES groups starts from -4.08 percentage points at birth and grows by 0.35 percentage points per year (7 points over 20 years). Fig. 1 shows the prediction of the chance of being overweight and obese based on a linear regression of overweight and obesity on age and age^2 across different maternal education levels.

Fig. 1. Quadratic Prediction Plots of Overweight/Obesity Over Age

[10] This could be calculated from the regression model with the estimated regressors in Column (4) of Table 3a.



Note: This figure is the prediction of the chance of being overweight and obese based on a linear regression of overweight and obesity on age and age^2.

Table 3b specifies SES as a continuous variable measured by years of maternal completed schooling. The basic model indicates that BMI (obesity) increases (decreases) statistically significant by 0.29 kg/m^2 (0.57 percentage points) per year of age and increases 0.44 kg/m^2 (0.03 percentage points) for each additional year of schooling completed by the mother. The age effects are consistent with those obtained from table 3a. Table 3c further includes both overweight and obesity prevalence. The results are similar in sign to table 3a, with a greater magnitude for each coefficient.

Table 3b. Econometric estimates of age and SES gradients in BMI and obesity-continuous SES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	BMI		WHO Reference Obesity Prevalence		China Reference Obesity Prevalence		Age<20	Age≥20
Age	0.287***	0.294***	-0.006***	-0.004***	-0.005***	-0.004***	-0.007***	0.000
	(0.004)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Mother education	0.044*	0.123**	0.000	0.015***	0.001	0.014***	0.013***	0.000
	(0.019)	(0.039)	(0.001)	(0.003)	(0.001)	(0.003)	(0.003)	(0.018)

(years)								
Age* mother education		-0.007* (0.003)		-0.001*** (0.000)		-0.001*** (0.000)	-0.001*** (0.000)	0.000 (0.001)
Female	-0.081 (0.042)	-0.077 (0.042)	-0.020*** (0.003)	-0.019*** (0.003)	-0.020*** (0.003)	-0.020*** (0.003)	-0.018*** (0.003)	-0.011* (0.005)
_cons	14.803*** (0.103)	14.698*** (0.113)	0.137*** (0.007)	0.1181*** (0.008)	0.134*** (0.007)	0.116*** (0.008)	0.131*** (0.009)	0.000 (0.025)
R^2	0.306	0.306	0.039	0.041	0.033	0.034	0.045	0.010
N	20104	20104	20104	20104	20104	20104	17369	2735

Note: The regression models in this table use continuous variable maternal education in years as the socioeconomic indicator. The regressions also control survey year. Standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 3c. Econometric estimates of age and SES gradients in BMI and overweight/obesity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	BMI		WHO Reference Overweight/Obesity Prevalence		China Reference Overweight/Obesity Prevalence		Age<20	Age≥20
Age	0.286*** (0.004)	0.288*** (0.010)	-0.007*** (0.000)	-0.017*** (0.001)	-0.005*** (0.000)	-0.010*** (0.001)	-0.016*** (0.001)	0.006 (0.008)
Low maternal education	0.191** (0.063)	-0.208 (0.134)	-0.017** (0.007)	-0.090*** (0.014)	-0.015* (0.007)	-0.101*** (0.014)	-0.051** (0.016)	-0.102 (0.197)
Median maternal education	0.194** (0.067)	-0.074 (0.145)	-0.013 (0.007)	-0.043** (0.015)	-0.011 (0.007)	-0.045** (0.015)	-0.034* (0.017)	-0.208 (0.222)
Age* Low maternal education		0.001 (0.011)		0.006*** (0.001)		0.006*** (0.001)	0.003* (0.001)	0.003 (0.008)
Age* Median maternal education		-0.011 (0.012)		0.003* (0.001)		0.003* (0.001)	0.002 (0.002)	0.009 (0.009)
Female	-0.081 (0.042)	-0.079 (0.042)	-0.031*** (0.004)	-0.030*** (0.004)	-0.032*** (0.005)	-0.031*** (0.005)	-0.022*** (0.005)	-0.035** (0.013)

_cons	15.025***	15.002***	0.280***	0.330***	0.271***	0.329***	0.331***	0.009
	(0.109)	(0.146)	(0.011)	(0.015)	(0.012)	(0.015)	(0.016)	(0.194)
R^2	0.306	0.306	0.009	0.009	0.008	0.010	0.018	0.027
N	20104	20104	20104	20104	20104	20104	17369	2735

Note: Standard errors are reported in parentheses. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Tables 4a-4c provides gender-specific estimates on the age effects of SES gradients. The average age effect is similar for males and females, but the SES disparity is considerably different between men and women. The low SES male BMI is 0.32 kg/m^2 higher on average than for high SES men at birth, while the low SES female BMI is 1.04 kg/m^2 lower than for high SES women at birth [Tables 4a-4b, Column (2)]. The SES disparity on BMI narrows by 0.05 per year of age for males and 0.08 per year of age for females. Male (female) obesity prevalence at birth is 3.24 (5.25) percentage points lower for low maternal education group than the high SES peers at 5% (0%) significance level. The coefficient on the interaction between age and low maternal education is 0.003 for males and 0.0043 for females. Therefore, the SES disparity is decreasing with age at early childhood, and reverses after becoming a teenager. The chance of obesity for a low SES girl is initially 2 percentage points lower than a boy, but the SES gradient on obesity rotates faster for women than men.

Table 4a. Male econometric estimates of age and SES gradients in BMI and obesity

	(1)	(2)	(3)	(4)	(5)	(6)
			WHO Reference		China Reference	
	BMI	BMI	obesity	obesity	obesity	obesity
Age	0.271***	0.317***	-0.006***	-0.008***	-0.005***	-0.007***
	(0.005)	(0.014)	(0.000)	(0.001)	(0.000)	(0.001)
Low mother education	-0.285***	0.325	0.003	-0.032*	0.001	-0.030*
	(0.086)	(0.182)	(0.006)	(0.014)	(0.007)	(0.014)
Median mother	-0.235*	0.188	0.000	-0.014	0.000	-0.013
	(0.092)	(0.196)	(0.007)	(0.015)	(0.007)	(0.015)

education						
Age* low mother education		-0.054*** (0.014)		0.003** (0.001)		0.003* (0.001)
Age* median mother education		-0.039* (0.016)		0.001 (0.001)		0.001 (0.001)
_cons	15.211*** (0.146)	14.745*** (0.196)	0.146*** (0.011)	0.170*** (0.015)	0.144*** (0.011)	0.165*** (0.015)
R^2	0.324	0.325	0.038	0.040	0.032	0.033
N	10986	10986	10986	10986	10986	10986

Note: Standard errors are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4b. Female econometric estimates of age and SES gradients in BMI and obesity

	(1)	(2)	(3)	(4)	(5)	(6)
			WHO Reference		China Reference	
	BMI	BMI	obesity	obesity	obesity	obesity
Age	0.307*** (0.006)	0.248*** (0.015)	-0.006*** (0.000)	0.009*** (0.001)	-0.005*** (0.000)	-0.009*** (0.001)
Low mother education	-0.074 (0.092)	-1.041*** (0.199)	-0.004 (0.006)	-0.053*** (0.013)	-0.004 (0.006)	-0.058*** (0.013)
Median mother education	-0.154 (0.098)	-0.404 (0.214)	-0.004 (0.006)	-0.018 (0.014)	-0.002 (0.006)	-0.026 (0.014)
Age* Low mother education		0.085*** (0.016)		0.004*** (0.001)		0.005*** (0.001)
Age* Median mother education		0.023 (0.018)		0.001 (0.001)		0.002 (0.001)
_cons	14.706*** (0.157)	15.326*** (0.212)	0.111*** (0.010)	0.142*** (0.013)	0.108*** (0.010)	0.145*** (0.014)
R^2	0.282	0.285	0.037	0.040	0.032	0.035
N	9118	9118	9118	9118	9118	9118

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4c incorporates both overweight and obesity prevalence to examine how the SES gradients rotate with age for men and women. The results are consistent with the results

shown in Tables 4a-4b, but at a stronger rate. Under China's criteria, male (female) overweight/obesity prevalence at birth is 5.11 (6.57) percentage points lower for the low maternal education group than high SES peers at 1% (0%) significance level. The coefficient on the interaction between age and low maternal education is 0.003 for males and 0.0048 for females. These results confirm that the SES gradient on obesity rotates faster for women than men.

Table 4c. Male and female econometric estimates of age and SES gradients in overweight/obesity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male Overweight/Obesity Prevalence				Female Overweight/Obesity Prevalence			
	WHO		China		WHO		China	
Age	-0.006***	-0.010***	-0.004***	-0.009***	-0.008***	-0.014***	-0.006***	-0.013***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Low mother education	-0.020*	-0.069***	-0.018	-0.081***	-0.015	-0.114***	-0.014	-0.124***
	(0.009)	(0.020)	(0.010)	(0.020)	(0.009)	(0.019)	(0.009)	(0.020)
Median mother education	-0.014	-0.034	-0.010	-0.041	-0.013	-0.052*	-0.014	-0.048*
	(0.010)	(0.021)	(0.010)	(0.022)	(0.009)	(0.021)	(0.009)	(0.021)
Age* Low mother education		0.004**		0.006***		0.009***		0.010***
		(0.002)		(0.002)		(0.002)		(0.002)
Age*Median mother education		0.002		0.003		0.004*		0.003
		(0.002)		(0.002)		(0.002)		(0.002)
_cons	0.275***	0.309***	0.264***	0.309***	0.260***	0.326***	0.251***	0.323***
	(0.016)	(0.021)	(0.016)	(0.022)	(0.015)	(0.021)	(0.016)	(0.021)
R^2	0.011	0.012	0.013	0.013	0.010	0.012	0.006	0.008
N	10986	10986	10986	10986	9118	9118	9118	9118

Note: Standard errors are reported in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5 presents the predictions of BMI and overweight and obesity prevalence for different age groups. The data are further stratified by gender and maternal education level. A low SES individual has the highest chance of being obese or overweight by the age of 20 and the disparity keeps rotating more with age. By age 40, the gradient is much steeper among different SES peers.

Table 6a relaxes the assumption that urban and rural residents have the same age and SES gradients by providing separate area-specific estimates. The SES disparities are much larger and rotate more with age for urban residents. The economic development disparity between urban and rural areas in China gives the urban residents more resources to consume a higher level of calories than rural residents.

Table 5: Predicted BMI and obesity/overweight prevalence by age and SES

	BMI		WHO				China			
			Overweight (%)		Obesity (%)		Overweight (%)		Obesity (%)	
Maternal Education	20 years old	40 years old	20 years old	40 years old	20 years old	40 years old	20 years old	20 years old	20 years old	40 years old
Full Sample										
Low	20.11	25.88	5.58	5.04	0.93	-8.88	7.31	9.97	1.55	-7.02
Medium	20.00	25.53	4.97	1.49	-1.03	-15.26	5.72	3.50	-0.05	-12.58
High	20.30	26.06	4.81	-1.44	-2.04	-18.90	5.47	0.38	-1.43	-17.22
Male										
Low	20.15	25.92	6.08	5.54	1.80	-8.01	7.80	10.46	2.45	-6.12
Medium	20.04	25.57	5.47	1.99	-0.16	-14.39	6.22	3.99	0.84	-11.68
High	20.34	26.09	5.31	-0.94	-1.17	-18.03	5.96	0.87	-0.53	-16.32
Female										
Low	20.07	25.84	4.98	4.44	-0.11	-9.93	6.71	9.37	0.47	-8.10
Medium	19.96	25.49	4.37	0.88	-2.08	-16.31	5.13	2.91	-1.14	-13.66

High	20.26	26.01	4.21	-2.05	-3.08	-19.95	4.87	-0.21	-2.51	-18.30

Note: Predictions are obtained from the estimation results of Table 3a.

Table 6b displays the area-gender-specific estimates. For both the urban and rural areas, SES disparities rotate more for women than men. The disadvantaged urban females (males) are initially 14.52 (11.03) percentage points less likely to be overweight or obese than their advantaged urban peer females, while the SES disparity for disadvantaged urban females (males) reverses direction with age and widens at 1.15 (0.62) percentage points per year of age.

Table 6a. Econometric estimates of age and SES gradients by living area (urban vs. rural)

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI		Overweight/Obesity		Obesity only	
	Urban	Rural	Urban	Rural	Urban	Rural
Age	0.240***	0.323***	-0.014***	-0.010***	-0.009***	-0.008***
	(0.019)	(0.019)	(0.002)	(0.002)	(0.001)	(0.001)
Low maternal educ	-0.392	0.216	-0.127***	-0.055*	-0.038	-0.036*
	(0.273)	(0.197)	(0.030)	(0.024)	(0.022)	(0.018)
Medium maternal educ	-0.462	0.406	-0.059	-0.015	-0.020	-0.009
	(0.284)	(0.216)	(0.031)	(0.026)	(0.022)	(0.019)
Age* Low mother educ	0.015	-0.026	0.009***	0.005*	0.004**	0.003*
	(0.020)	(0.019)	(0.002)	(0.002)	(0.001)	(0.001)
Age* medium mother educ	0.027	-0.048*	0.005*	0.001	0.002	0.001
	(0.022)	(0.021)	(0.002)	(0.002)	(0.002)	(0.001)
Female	-0.117	-0.080	-0.026**	-0.034***	-0.010	-0.023***
	(0.086)	(0.048)	(0.009)	(0.005)	(0.006)	(0.003)
_cons	15.243***	14.617***	0.360***	0.299***	0.174***	0.159***
	(0.231)	(0.188)	(0.033)	(0.026)	(0.025)	(0.019)
R^2	0.259	0.329	0.047	0.036	0.049	0.039
N	5639	14465	5639	14465	5639	14465

Note: Obesity and overweight are reported based on WHO criteria. Standard errors are reported in parentheses. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

Table 6b. Econometric estimates of age and SES gradients by gender and living area

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Overweight/Obesity (WHO)				Overweight/Obesity (China)			
	Urban		Rural		Urban		Rural	
	Male	Female	Male	Female	Male	Female	Male	Female
Age	-0.011***	-0.018***	-0.009***	-0.011***	-0.009***	-0.017***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Low maternal	-0.110**	-0.145***	-0.048	-0.060*	-0.123***	-0.162***	-0.064*	-0.067*

education	(0.035)	(0.034)	(0.025)	(0.025)	(0.036)	(0.035)	(0.026)	(0.026)
Age* low maternal education	0.006*	0.012***	0.003	0.006**	0.007**	0.013***	0.005*	0.006**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Medium maternal education	-0.040	-0.078*	-0.021	-0.005	-0.053	-0.076*	-0.028	0.002
	(0.036)	(0.034)	(0.027)	(0.027)	(0.037)	(0.035)	(0.028)	(0.028)
Age*medium maternal education	0.004	0.006*	0.000	0.001	0.006*	0.005	0.001	-0.000
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
_cons	0.336***	0.362***	0.290***	0.276***	0.335***	0.360***	0.295***	0.270***
	(0.037)	(0.035)	(0.027)	(0.027)	(0.039)	(0.036)	(0.028)	(0.028)
R^2	0.038	0.063	0.040	0.035	0.032	0.052	0.032	0.024
N	2946	2693	8040	6425	2946	2693	8040	6425

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To investigate the possible mechanisms for the above findings that the SES gradients rotate with age, the estimates of equation (3) using adult sample are presented in Tables 7a-7d.[11] There is a great deal of evidence that the SES at young ages is related with adult overweight or obesity. Adult weight could be affected by contemporaneous socioeconomic conditions, which might be highly correlated with early life SES. Another possible situation is that the early life SES is the determinant of adult weight instead of adult SES. The last possibility is that both early life SES and adult socioeconomic conditions have independent effects. Early life SES and current SES are proxied by maternal education level and respondent's completed grade, respectively.[12] The estimations in Tables 7a-7b assume that the childhood SES and contemporaneous SES gradients are the same for males and females. The average BMI rises with age during adulthood. The results show that neither the

[11] Only adult respondents (age>18) are used for this analysis.

[12] The education level are categorized by 7 groups: 0-none, 1-graduated from primary school, 2-lower middle school degree, 3-upper middle school degree, 4-technical, or vocational degree, 5-university or college degree, and 6-master's degree or higher.

childhood nor adult SES gradient for obesity is found, but early life SES is a significant determinant of overweight prevalence while adult SES is not. The chance of being overweight or obese is 0.93 percentage points greater when the respondent's maternal education increases one level (5% significance).

To further investigate the gender differences in the possible SES transmission processes, Tables 7c-7d report the gender-specific estimates of equation (3). The most interesting results show that the current SES of a man has a significantly positive relationship with his chance of being overweight or obese, while early childhood SES becomes insignificant. On the contrary, the current SES of a woman has a significantly negative relationship with her chance of being overweight or obese. Specifically, the chance of being overweight or obese for males increases by 1.52 percentage points when the current education rises by one level. The chance of being overweight or obese for females decreases by 1.9 percentage points when the current education rises one level.

Table 7a. Econometric estimates of obesity and current/childhood SES gradients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		BMI		WHO Reference Obesity			China Reference Obesity		
Age	0.115***	0.116***	0.117***	0.001	0.001	0.001	0.003***	0.003***	0.003***
	(0.014)	(0.014)	(0.015)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Maternal education	-0.020		0.019	0.002		0.002	0.006*		0.005*
	(0.049)		(0.053)	(0.002)		(0.002)	(0.002)		(0.003)
Respondent education		-0.086	-0.092		0.000	-0.000		0.004	0.002
		(0.044)	(0.047)		(0.002)	(0.002)		(0.002)	(0.002)
Female	-0.192	-0.179	-0.180	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006
	(0.100)	(0.101)	(0.101)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
_cons	18.43***	18.55***	18.52***	-0.009	-0.007	-0.009	0.06***	0.06***	0.06***
	(0.329)	(0.331)	(0.337)	(0.012)	(0.013)	(0.013)	(0.016)	(0.017)	(0.017)
R^2	0.040	0.042	0.042	0.009	0.009	0.009	0.019	0.018	0.019
N	4162	4122	4122	4162	4122	4122	4162	4122	4122

Note: Standard errors in parentheses. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Table 7b. Econometric estimates of overweight/obesity and current/childhood SES gradients

	(1)	(2)	(3)	(4)	(5)	(6)
	Overweight/Obesity Prevalence (WHO)			Overweight/Obesity Prevalence (China)		
Age	0.011***	0.011***	0.011***	0.016***	0.015***	0.016***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Mother education	0.009*		0.009*	0.008		0.010
	(0.004)		(0.005)	(0.005)		(0.006)
Respondent educ		0.002	-0.001		-0.000	-0.003
		(0.004)	(0.004)		(0.005)	(0.005)
Female	-0.011	-0.010	-0.010	-0.006	-0.004	-0.005
	(0.009)	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)
_cons	-0.174***	-0.162***	-0.173***	-0.260***	-0.246***	-0.257***
	(0.030)	(0.030)	(0.030)	(0.034)	(0.035)	(0.035)
R^2	0.041	0.040	0.041	0.051	0.050	0.051
N	4162	4122	4122	4162	4122	4122

Note: Standard errors in parentheses. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Table 7c. Overweight/obesity and current/childhood SES gradients for males

	(1)	(2)	(3)	(4)	(5)	(6)
	Overweight/Obesity Prevalence (WHO)			Overweight/Obesity Prevalence (China)		
Age	0.011***	0.010***	0.011***	0.015***	0.014***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mother Education	0.017**		0.012	0.018**		0.012
	(0.006)		(0.007)	(0.007)		(0.007)
Respondent education		0.019**	0.015*		0.023***	0.019**
		(0.006)	(0.006)		(0.006)	(0.008)
_cons	-0.134**	-0.140**	-0.168***	-0.169**	-0.185***	-0.213***
	(0.047)	(0.047)	(0.050)	(0.054)	(0.053)	(0.056)
R^2	0.055	0.057	0.058	0.065	0.068	0.069
N	2567	2544	2544	2567	2544	2544

Note: Standard errors in parentheses. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Table 7d. Overweight/obesity and current/childhood SES gradients for females

	(1)	(2)	(3)	(4)	(5)	(6)
	Overweight/Obesity Prevalence (WHO)			Overweight/Obesity Prevalence (China)		
Age	0.009***	0.009***	0.009***	0.018***	0.018***	0.018***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)

Mother Education	-0.000		0.008	-0.005		0.007
	(0.006)		(0.007)	(0.007)		(0.008)
Respondent education		-0.016**	-0.019***		-0.025***	-0.028***
		(0.005)	(0.006)		(0.006)	(0.007)
_cons	-0.109*	-0.080	-0.086	-0.264***	-0.228***	-0.233***
	(0.046)	(0.047)	(0.047)	(0.055)	(0.056)	(0.056)
R^2	0.016	0.022	0.023	0.031	0.041	0.041
N	1595	1578	1578	1595	1578	1578

Note: Standard errors in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

The different gender-specific current SES gradients may stem from a variety of factors. One of the most important reasons could be that the job and marriage markets for females are quite different. Better educated women tend to have better information on the benefits of fitness, and thus remain competitive in both job and marriage markets. On the contrary, Chinese males are much less sensitive to their shape than females and sometimes being a little overweight is a symbol of wealth in Chinese culture. This also implies that the public health policy on Chinese overweight and obesity problem should take into account the gender difference.

6. Conclusion

Overweight and Obesity, defined as a disease by the World Health Organization (WHO), are studied as risk factors for many other chronic diseases such as cardiovascular disease, diabetes and hypertension. Average BMI rises with age from early childhood to middle adulthood. The fact that SES differences in obesity and overweight grow with age from the early adulthood confirms the results of previous research on other health outcomes. This paper goes further and provides new evidence of age profile of SES-gradients. First, until

about 12 year olds, the SES is positively associated with the chance of being obese or overweight. That is, children from mothers with higher maternal education are subject to a higher risk of obesity and being overweight. This trend diminishes gradually as children age into adulthood. SES-gradients in BMI and obesity rotate over age, consistent with previous research results. Second, the SES gaps of overweight and obesity are generally larger for urban residents than rural residents. The disadvantaged urban female residents are the least likely group to be overweight in their early life, but the corresponding SES-gradient rotates the most with age. Third, the SES transmission process is different for men and women in China. Higher adult SES is associated with a higher chance of obesity and being overweight for males, but is associated with a lower chance of obesity and being overweight for females.

It is important to understand and address the reasons behind this new empirical evidence. The observed linkages are not necessarily causal. This paper does not address whether rural/urban and gender disparities result from omitted characteristics. Information on the physical activities, energy intake and family income could be considered in the regression analysis for future research intending to fully understand the mechanism behind these patterns.

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Appendix: Weight Classifications Based on BMI for Adults

	Underweight	Normal weight	Overweight	Obesity	Overweight and Obesity
(1) WHO Standard	BMI<20	20≤BMI<25	25≤BMI<30	BMI≥30	BMI≥25
(2) Chinese Standard	BMI<18.5	18.5≤BMI<24	24≤BMI<28	BMI≥28	BMI≥24