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Socioeconomic determinants of childhood overweight and obesity in China: the long arm of institutional power

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Abstract

Abstract Previous studies have widely reported that the association between socioeconomic status (SES) and childhood overweight and obesity in China is significant and positive, which lends little support to the fundamental-cause perspective. Using multiple waves (1997, 2000, 2004 and 2006) of the China Health and Nutrition Survey (CHNS) (N = 2,556, 2,063, 1,431 and 1,242, respectively) and continuous BMI cut-points obtained from a polynomial method, (mixed-effect) logistic regression analyses show that parental state-sector employment, an important, yet overlooked, indicator of political power during the market transformation has changed from a risk factor for childhood overweight/obesity in 1997 to a protective factor for childhood overweight/obesity in 2006. Results from quantile regression analyses generate the same conclusions and demonstrate that the protective effect of parental state sector employment at high percentiles of BMI is robust under different estimation strategies. By bridging the fundamental causes perspective and theories of market transformation, this research not only documents the effect of political power on childhood overweight/obesity but also calls for the use of multifaceted, culturally-relevant stratification measures in testing the fundamental cause perspective across time and space.

Keywords

overweight; China; state sector; workplace; socioeconomic status

Introduction

The rising prevalence of childhood overweight and obesity has been widely recognised as an alarming issue (Popkin 2008, Chan *et al*. 2010, Shan *et al*. 2010, Jones-Smith *et al*. 2011a,

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Logistic (longitudinal) analyses of overweight/obesity among males aged 1–18 years: 1997 to 2006

Table S2. Logistic (longitudinal) analyses of overweight/obesity among females aged 1– 18 years: 1997 to 2006

Table S3. Logistic (longitudinal) analyses of overweight/obesity among individuals aged 1a–10 years: 1997 to 2006

Table S4. Logistic (longitudinal) analyses of overweight/obesity among individuals aged 11–18 years: 1997 to 2006

Table S5. Logistic (longitudinal) analyses of overweight/obesity among individuals aged 1– 18 years and interviewed in the 1997 wave: 1997 to 2006

Cui and Dibley 2012). From the life course perspective, childhood overweight poses a potential threat to subsequent health not only because it often extends into adulthood, but also because of its significant influence on all-cause mortality and diseases such as cardiovascular disease, diabetes, and hypertension later in life (Dietz 1998, The *et al*. 2010). For example, in a US study, elevated morbidity and mortality were observed for adults who were overweight as adolescents, even if they had normal weight as adults (Deckelbaum and Williams 2001). Due to the social stigma and body-image stress attached to body weight, overweight and obese children also tend to be the victims of bullying, have high levels of psychiatric disorder, and exhibit poor academic performance, which can have profound lifetime influences beyond health (Do and Finkelstein 2011, Mamun *et al*. 2012).

Examining socioeconomic determinants of childhood overweight and obesity in China can provide insights about recent social and economic forces driving the overweight epidemic among children in both developing countries and post-socialist societies. With accelerated market transformation since the early 1990s, children with certain socioeconomic characteristics (e.g. high-income families) have recently showed an unparalleled increase in overweight and obesity (e.g. Luo and Hu 2002, Cui *et al*. 2010). Yet, as traditional socioeconomic indicators (such as income and education) established in the Western context, though useful, are inadequate proxies for power and privilege in (post-)socialist societies (Weber 1946, Marx 1977, Lin and Bian 1991, Walder 1992, Bian and Logan 1996, Zhou 2000, scholars and policymakers remain unclear about how the rising epidemic of childhood obesity is unfolding unequally across Chinese society.

By bridging existing theoretical frameworks on fundamental causes of disease and theories of market transformation, this research explores socioeconomic gradients in childhood overweight/obesity in reform-era China. It specifically addresses two research questions. First, are indicators of stratification not typically used in health research – but suggested in market transformation literature – related to childhood obesity/overweight in China? In particular, does political power in the reform-era socialist regime affect the rising epidemic of childhood overweight? Second, because China is in the midst of far-reaching economic reforms and rapid social changes have the associations between socioeconomic status (SES) indicators and childhood overweight/obesity shifted over time? Based on data from consecutive waves of the China Health and Nutrition Survey (1997, 2000, 2004 and 2006), several meaningful indicators of stratification – including those both included in and overlooked by previous health studies – are examined. Next we discuss how research on stratification, especially in (post-) socialist societies, could contribute to our understanding of health disparities.

Theoretical framework

Robust relationships between stratification and health have been observed in data spanning centuries, with those at the top of stratification hierarchies having better health and longer lives than those at the bottom of the hierarchies. Socioeconomic status has been the form of stratification most frequently examined in research on health inequalities. Although other forms of stratification, including race/ethnicity, gender, and residential environments, are also commonly associated with health, research in developed countries suggests that SES is

the form of stratification most consistently and most strongly related to health. This does not mean, however, that SES (variously measured in terms of education, income, and, less often, occupation) is the most important form of stratification affecting health outcomes across countries. The search of meaningful stratification measures calls for an understanding of the basis of stratification in a specific society.

In their classic perspectives on social stratification, both Weber and Marx focused on power as the primary basis of stratification. In his timeless essay, Weber (1946) documented the links among social class, status, and political party involvement. He contended that all three of these forms of social location were important avenues to power. Likewise, for Marx (1977), owning the means of economic production was the basis of the power to control one's life and usurp workers' power. It is likely that SES is a better proxy for power in some societies and at some historical times than others. Yet, scholars should be cautious in interpreting SES as universal indicators of power and privilege, especially in (post-)socialist societies.

To assess more relevant stratification indicators in (post-)socialist societies, this research thus draws upon two theoretical perspectives that have greatly shaped studies in medical sociology and stratification over the last two decades: fundamental causes of disease theory and theories of market transformation. Fundamental causes of disease theory (Link and Phelan 1995) posits that socioeconomic status and perhaps other social factors are the fundamental determinants of disease. The distinction between proximate and distal causes is a critical element of this theory. Fundamental causes are distal causes and maintain strong relationships with health despite changes in more proximate causes of specific health outcomes. Historically, major public health advances including clean water, safe sanitation, and widespread immunisations did not change the pattern in which lower SES persons had more illnesses and died earlier than high SES individuals did. The mechanism by which SES and other fundamental causes exert their powerful and wide-ranging effects on health is differential access to resources (such as wealth, social capital, and knowledge) that minimise risk of illness and are associated with early diagnosis and the most advanced treatments. Consequently, health disparities persist as long as socioeconomic resources are distributed unequally, even though proximate causes of diseases are continuously identified and regulated.

The first step when employing fundamental-cause theory is identifying stratification indicators that are meaningful in the specific society under study. Theories of market transformation provide insights into how stratification in post-socialist societies can best be conceptualised. Drawing upon the argument that social inequalities in socialist states must distinguish between immediate producers and redistributors, Nee (1989) proposed that the market transition in China would gradually reward producers more than redistributors (e.g. cadres). Although this bold statement aroused extensive debates on who gains and who loses during the reform era, subsequent studies find that positional power continues to confer advantages upon incumbents because the control of resources allows cadres, either as agents of central authority or administrators of local economies, to claim benefits from the marketplace (Walder 1992, Bian and Logan 1996, Zhou 2000). Thus, administrative jobs

(e.g. cadres and business administrators) should remain indicators of privilege and power in reform-era China.

Nevertheless, social inequality in contemporary China is probably more shaped by institutional power possessed by work units (workplace or *danwei*) than by positional power attached to individuals (Lin and Bian 1991, Walder 1992, Bian and Logan 1996, Zhou 2000). When economic and social resources were under state ownership in the pre-reform era, work units in China were the primary institutional channels through which both economic activities and social life were organised (Lin and Bian 1991, Bian and Logan 1996). Work units not only facilitated the centrally planned economy via resource allocation, production and labour distribution, but also maintained the Party's societal control. A work unit assuming an 'all-encompassing' role for its employees (Walder 1986) provided a variety of benefits beyond economic reward. As noted by Bray (2005), these benefits included housing, medical care, child care, dining, bathing, permanent employment, political status, social identity and sense of belonging.

Even in contemporary urban China, the work-unit system continues to be an important agent of social stratification and constitutes a more fundamental cause of disease than education and income. The power possessed by work units persists in the reform era because, triggered by the state's emphasis on market performance, economic and administrative decentralisation has transferred substantial decision-marking power from the state to work units, thus empowering the latter (Bian and Logan 1996, Xie and Wu 2008, Zhou 2000). Be it an extension of China's traditional clan system or a common practice of personnel management adopted in other socialist regimes, empowered work units could maintain a patriarchal-type authority over their members. This particular patron-client relation both emphasises collective responsibility over individual rights and assumes that the well-being of workers is taken care of by a work unit. It is thus demonstrated that 'one cannot truly understand social stratification in China without properly understanding the important role played by the *danwei*' (Xie and Wu 2008: 580).

The hierarchy of work units then reflects power relations and privileges in Soviet stratification systems.[1] Because work units are assigned different priorities according to their importance in the planned economy, this segmentation of work units, in turn, determines individuals' entitlement to private benefits and public goods (Lin and Bian 1991). After reforms in the early 1990s substantially reduced the size of work units under state ownership to enhance their market performance, benefits are now concentrated in the remaining state sectors including government agencies, institutes and state-owned enterprises, which are vital to Communist rule and bedrocks of China's party-state. As compared with non-state sectors possessing peripheral positions in China's economy, state sectors occupying core positions are capable of negotiating with authorities and providing workers with various advantages (Lin and Bian 1991, Walder 1992, Xie and Wu 2008, Xie *et al.* 2009). For example, more recent research shows that state-sector employment is positively and significantly associated with earnings, medical benefits, housing sizes and

[1]Although this study does not intend to compare work-unit systems across socialist countries, Demick's (2010) groundbreaking field research reveals that the work-unit system also greatly shapes stratification in North Korea.

pensions for retirees in reform-era China (Xie and Wu 2008, Xie *et al.* 2009). By providing hidden bonuses or welfare benefits that are absent in non-state sectors, state sectors are able to create a more egalitarian environment within a work unit (Xie and Wu 2008, Xie *et al.* 2009). In addition, affiliation with a state-sector work unit often provides a sense of community, political identity and adequate resources embedded in a dense network within the work unit (Bian and Zhang 2001, Bray 2005). If the fundamental-cause theory is correct, we expect that parental state-sector employment should, among all SES indicators and other stratification measures, emerge as a protective factor for childhood overweight/obesity in reform-era China, which echoes the notion that 'entrance into the core sectors (state agencies and enterprises), rather than the job per se, constitutes the primary goal of status attainment' (Lin and Bian 1991: 657).

Childhood overweight and obesity in China: the role of SES

Findings from existing research can be summarised as follows. First, a significant positive association between SES and childhood overweight and obesity in China is widely reported in both cross-sectional and longitudinal studies. Second, a few recent studies do suggest a possible negative association between SES and overweight in China. Third, among all these studies, SES is conceptualised and measured as parental education, household income, and, less frequently, possession of luxury items (e.g. televisions, computers). Note, however, that several potentially important indicators of stratification in China, such as state-sector employment and administrative jobs, have not yet been investigated with regard to childhood overweight/obesity. The current research thus aims to fill this gap in research to date.

In a cross-national study, Wang (2001) found that children (aged 6–18) from high-income families had higher rates of obesity in China (1993) and Russia (1992) than children in low-income families. In contrast, a negative relationship between per capita household income and childhood obesity was observed in the US (NHANES III, 1988–1994). A more recent study also demonstrated that Chinese children from high-income families had higher prevalence of overweight and obesity than children from less advantaged families in 2006 (Cui *et al.* 2010). Likewise, a study based on 3,140 students ages 7 to 18 years in Tianjin showed that both urban residency and higher parental education were significantly associated with the risk of being overweight or obese in 2010 (Andegiorgish *et al.* 2012). With regard to regional disparities in childhood overweight and obesity, a study based on a large nationally representative sample (226,602 subjects) found that children and adolescents living in urban areas, coastal regions and northern parts of China had higher prevalence rates of overweight and obesity than those in rural areas and other regions in 2005 (Ji and Cheng 2009).

The positive relationship between childhood overweight/obesity and SES revealed by these cross-sectional studies is further supported by a few longitudinal studies that examined time trends. Luo and Hu (2002) conducted both repeated cross-sectional and longitudinal analyses on several consecutive waves of the China Health and Nutrition Survey (CHNS 1989, 1991, 1993 and 1997), using a sample of children aged 2 to 6 years. High and medium household income, assessed in 1989, was shown to be independent risk factors for childhood overweight in 1997. When auto-correlations from repeated measurements across surveys

were taken into account, a study investigating the temporal trends of childhood overweight and obesity showed that urban children constantly had higher rates than their rural peers from 1991 to 2006 (except for the prevalence of obesity in 1997) (Cui *et al*. 2010).

Although most studies reported positive associations between SES indicators and childhood overweight/obesity, a possible negative association is implied by several studies. Using both individual- and aggregate-level data across 67 countries from 2002 to 2003, Pampel *et al*. (2012) found that the association between SES and the risk of being overweight or obese had changed from positive to negative as national product increased. A longitudinal study on adulthood overweight also lends support to a shifting socioeconomic gradient in overweight over time and finds that low SES has become a risk factor for overweight prevalence among Chinese women in more recent years (Jones-Smith *et al*. 2011b). Direct evidence of a negative association between SES and childhood obesity in China came from a study based on children aged 1–35 months in Beijing. In this study, lower parental education was related to childhood overweight in 2005 (Jiang *et al*. 2009).

Data, measures and methods

Data

This research is based on data from the China Health and Nutrition Survey (CHNS) conducted by the Carolina Population Center and several collaborative institutes in China. The survey covers nine provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong) that vary substantially in geographical region, economic development, social resources, and health status. The CHNS adopts an open-cohort design such that participants are followed over time once recruited to the study. New participants are also recruited at each time of measurement. Within each province, a stratified sampling design was used to select counties and cities with different levels of per capita income. Rural villages/townships within selected counties and urban areas in selected cities were then randomly selected. Within each of these geographic units, approximately 20 households and individuals within households were randomly selected and interviewed.

The sample for this analysis included 2,556, 2,063, 1,431 and 1,242 CHNS participants aged 1–18 in 1997, 2000, 2004 and 2006, respectively. Among the 2556 participants interviewed in the 1997 wave, 1,416, 526 and 284 of them are tracked in 2000, 2004 and 2006, respectively. We chose 1997 instead of the beginning year of the CHNS (1989) as the first time of measurement for two reasons. First, the associations between SES and childhood overweight/obesity from 1989 to 1997 were reported in previous studies using the same data (Wang 2001, Luo and Hu 2002). Second, policy changes affecting state sectors occurred throughout the 1990s in China, with an especially important fiscal reform introduced in 1994 (Fu and Lin 2013). It was important to restrict the analysis to the times of measurement after 1994 so that the fiscal reform does not confound the results.

Measures

Childhood overweight/obesity—We used the age and sex-specific BMI cut-points proposed by the International Obesity Task Force (IOTF) to identify childhood overweight/

obesity, which are generated by fitting centile curves to pass through the widely used adult cut-points for obesity (30 kg/m^2) and overweight (25 kg/m^2) at age 18. Because the IOTF provides age and sex-specific cut-points for six-month intervals for children aged 2 and older, we used a polynomial method to produce continuous cut-points for children aged 1–18. Results from this polynomial interpolation provided BMI cut-points for each child's exact age. Using Matlab (R2011b, Mathworks, Inc., Natick, MA, USA), the fitted continuous curves for childhood overweight achieve an almost perfect fit for both boys and girls (See Figure 1: $R^2 > 0.9999$ and the sum of squared residuals <0.07 for both panels). Children with BMI equal to or above the age-specific cut-point for overweight are identified as overweight/obesity, including both obese and overweight individuals.

However, because Asian populations have a higher proportion of body fat at a lower BMI than White (Deurenberg *et al.* 2002, consensus is lacking about whether the 'universal' cut-points proposed by the IOTF can be appropriately applied to the Chinese population. For example, the populations China Obesity Task Force (Ji 2005) found that BMI cut-points for screening childhood overweight in China tended to be lower than the IOTF guidelines. Instead, the China Obesity Task Force recommends using the 85th percentile of BMI as the criterion for childhood overweight, especially for Chinese children age 7 to 18. We thus examine two measures of overweight/obesity. The first is a dichotomous measure of overweight/obese (coded 1) vs. normal weight (coded 0) using the conventional IOTF guidelines. The second is a quantile measure of BMI.

Socioeconomic determinants (SES)—Four SES and stratification measures are employed: parental years of schooling; per capita household income; parental state-sector employment and parental administrative job. Parental education is a continuous variable measuring the parent's years of schooling in a single-parent household or the parents' average years of schooling in a two-parent household. Per capita household income includes income during the last year from all sources, is a continuous measure, and is adjusted for household sizes and inflation. While income and educational attainment are widely used indicators of SES across countries, market transformation theory suggests that state-sector employment and holding an administrative job, especially the former, are important indicators of stratification in reform-era China. Parental state sector is a dummy variable measuring whether at least one parent works in a state sector (government department, state service/institute, or state-owned enterprise). Likewise, parental administrative job was coded as one if either parent is an administrator, an executive, a manager, an army officer or a police officer and coded zero otherwise. The coding of the last two variables is consistent with existing research on market transformation. (Bian and Logan 1996, Zhou 2000).

Demographic, geographic and parental anthropometric characteristics—These are included as control variables. Previous studies report that individuals located in urban, northern or coastal regions in China tend to have higher overweight/obesity prevalence than those living in rural, southern or inner regions (Gu *et al.* 2005, Reynolds *et al.* 2007, Ji and Cheng 2009, Cui *et al.* 2010). Three dummy variables are used to control for regional disparities. Rural residency (rural areas = 1, otherwise = 0), based on whether the respondent lived in a village, controls for China's rural-urban divide. Coastal and middle regions refer to

provinces located in the eastern (Heilongjiang, Liaoning, Jiangsu, and Shandong) and middle (Henan, Hubei, and Hunan) parts of China. The reference group is western regions (Guangxi and Guizhou). Southern regions include Guangxi, Guizhou, Hubei, Hunan, and Jiangsu provinces; all other provinces (Heilongjiang, Henan, Liaoning and Shandong) are the reference group. Children's sex (male = 1) and age (in years) were included. Parental age and BMI are continuous variables and are averaged for two-parent households. Finally, number of children (ages 0–17) in the household (measured as a count), multi-generational household (coded one if there are three or more generations in a single household and zero otherwise), and living in a two-parent household (coded one if both parents lived in the household and zero otherwise) are included to control for family structure.

Analytic methods—The associations between socioeconomic determinants and childhood overweight/obesity were examined primarily using logistic regression models. Because the CHNS is a longitudinal open-cohort survey, about 40 per cent of the analytic sample (2,995 out of 7,292 observations) were repeated observations. To account for the within-person autocorrelation of error terms, longitudinal logistic models were employed to study the pooled sample. The disadvantage of longitudinal analyses of the pooled sample, however, is that they do not allow the effects of covariates to vary across different survey waves unless numerous interactions between all covariates and survey waves are included in an overfitted model. Cross-sectional logistic analyses allowing for wave-specific effects of covariates were thus conducted. All (longitudinal) logistic analyses were estimated using STATA (Version 11, STATA Corp Inc., College Station, TX, USA) and the results were verified by PROC GLIMMIX in SAS (Version 9.3.1, SAS Institute Inc., Cary, NC, USA).

As previously noted, the China Obesity Task Force (Ji 2005) recommended using 85th percentiles to measure childhood overweight. In response to this concern, logistic analyses were complemented by quantile regression to investigate the effects of stratification measures at high BMI percentiles, adjusting for a series of control variables. Due to relatively small sample sizes across percentiles, the robustness of our results was tested using different estimation strategies (asymptotic estimation, kernel density estimation and bootstrap estimation) in R.

Results

Descriptive statistics for variables used in this study are provided in Table 1. Although the increase in average BMI from 1997 to 2006 is modest, childhood overweight/obesity increased substantially over the period of study (from 6.5% to 11.3%). The age and sex distributions are relatively stable across waves. The decrease in the number of children per household may reflect the effect of family planning policies and declined fertility rates in China. The rise in divorce rates likely accounts for fewer children living in two-parent households in more recent waves (Jones 2010). Two factors help account for the increase in multi-generational households. In rural regions, children often live with their grandparents when either or both of their working-age parents are looking for urban jobs (Silverstein *et al.* 2006). For urban residents, exorbitant housing prices (Fu and Lin 2013) make it difficult to afford nuclear-based households, making more multi-generational households likely. Parental age declines modestly over time. As expected, parental BMI slightly increases

across waves. Higher proportions of participants are from rural, non-western, and southern regions. However, interviewees from developed coastal regions increase steadily over time. Both inflation-adjusted per capita household income (from 3,700 yuan to 6,900 yuan) and parental years of schooling (from 6.9 years to 7.9 years) increased monotonically from 1997 to 2006 as a result of China's economic growth and the expansion of its education system. The proportions of parents holding administrative jobs or working in state sectors, however, remained relatively stable from 1997 to 2006, exhibiting a different time trend for the context-specific, as compared to the conventional, dimensions of stratification.

Results from the logistic regression models predicting childhood overweight/obesity are presented in Table 2. In general, SES is not a strong predictor of childhood overweight/obesity. Parental education and parental administrative job are not significant predictors in any of the cross-sectional models or for the pooled sample. The coefficients for household income are small and differ in direction across models. It is a significant, positive predictor only in the 2000 model. For effects of parental state sector, the coefficients are statistically significant for the 1997 (Odds Ratio, or OR = 1.632) and 2006 waves (OR = 0.348), but in opposite directions. In the pooled sample, the coefficient is negative and approaches significance. The interaction between parental state sector job and time of measurement, however, is significant, negative, and substantively quite large (OR = 0.257). Thus, compared to 1997, parental state sector employment in 2006 decreased the likelihood of childhood overweight/obesity. We also find that the protective effect of parental state sector in the 2006 wave remains robust if logistic regression analyses are based on separate sex and age groups, or the subset of children remaining in the panel throughout the period of study (see online supplements). The main effects for time (i.e., time of measurement) are significant and positive for the 2004 and 2006 waves (OR = 1.582 and 2.403, respectively), exhibiting the expected pattern of higher rates of overweight/obesity in more recent years.

The effects of the demographic and anthropometric variables do not show consistent patterns in the four cross-sectional models. Two predictors are significant for the pooled sample. Age is negatively associated with childhood overweight/obesity. As expected, parental BMI is positively associated with childhood overweight/obesity. Although rural vs. urban residence is only marginally associated with overweight/obesity, regional disparities are somewhat more consistent. All three coefficients for the regional variables are significant. Thus, compared to residence in the western region, both coastal and middle region residence are associated with higher odds of overweight/obesity. In addition, compared to living in northern regions, residence in the southern regions is associated with significantly lower odds of overweight/obesity.

We next use quantile regression models (Koenker 2005) to investigate whether the protective effect of parental state-sector employment in the 2006 wave remains robust if high BMI percentiles instead of a dichotomous measure are used to denote childhood overweight/obesity. Net of other effects, results showed that the zero horizontal line was above the 95% confidence bounds of the estimated effects of parental state sector at the 85th and higher percentiles of children's BMI distribution. If we recall that the 85th percentile of the BMI distribution has been shown to be the criterion for screening childhood overweight in China (Ji 2005), these results mean that state-state sector employment significantly reduces the

BMI of overweight children. Thus, results obtained from quantile regression also support the protective effect of parental state-sector employment in 2006. Another interesting finding from the quantile regression is that parental state-sector employment not only reduces BMI at the higher end of the BMI distribution, but also increases children's BMI at the lower end of the distribution. The positive effects of parental state-sector employment are significant at the 0.05 significance level around the 25th percentile. Results from the ordinary least squares (OLS) estimation in Figure 2 also suggest that parental state-sector employment has a negative and marginally significant effect (significant at the 0.1 significance level) on overall BMI. In an auxiliary analysis, results obtained from the quantile regression revealed that none of the other three SES indicators (parental administrative jobs, family income and parental education) significantly reduced BMI at any BMI percentile.

Because the classical independent and identically distributed (i.i.d.) assumption about the error structure of asymptotic estimation can be violated under small or moderate sample sizes, two alternative methods of estimation – kernel density estimation and bootstrap estimation (Powell 1991, Koenker 2005) – were used to test the robustness of the results from the quantile regression models. Coefficients and 95% confidence bounds of parental state-sector employment across percentiles are consistent with those graphed in Figure 2. Parental state-sector employment significantly reduced BMI at the higher end of children's BMI distribution and the homeostatic effects of parental state-sector employment remained salient at lower BMI percentiles. Therefore, conclusions drawn from asymptotic estimation held under different estimation strategies.

Conclusions and discussion

We first describe how the results of this study bear on those two questions and then discuss their possible implications for fundamental causes theory. To address the first research question, we examined four stratification measures. Parental education and household income are conventional SES indicators in developed countries and in most previous studies of childhood overweight/obesity in developing countries. Drawing on stratification literature in (post-)socialist societies, we also examined parental state-sector employment and parental employment in an administrative job. In this sample, conventional SES indicators in developed countries were not strongly related to childhood overweight/obesity in China during the decade between 1997 and 2006. Neither parental education nor household income was a significant predictor of childhood overweight/obesity in the pooled logistic model. In analyses of the four specific times of measurement, parental education was never a significant predictor of childhood overweight/ obesity and household income was a significant predictor only in 2000. Parental education and household income were also not significant predictors of childhood BMI.

The associations of the culture-specific SES indicators – parental administrative job and parental state-sector employment – with childhood overweight/obesity are mixed. Parental administrative job was not a significant predictor of overweight/obese in the pooled and year-specific logistic models; nor did it predict childhood BMI. In the year-specific analyses, parental state sector job was positively related to childhood overweight/obesity in 1997 and negatively related to overweight/obesity in 2006. Because the direction of this relationship

varied across times of measurement, the main effect of parental state sector job was marginally significant in the pooled logistic model.

We addressed the second research question by examining possible interactions between time of measurement and the SES indicators. Compatible with the pattern across year-specific models, the interaction of parental state-sector employment and the year 2006 was significant and negative in the pooled sample. This general pattern also was observed in the quantile and OLS regression models predicting childhood BMI in the 2006 wave.

State-sector employment in China is a distinct advantage and its benefits, such as job security, housing allocation, pensions, health care and social capital, go well beyond income and occupation per se (McMillan and Naughton 1992, Lin *et al.* 1998, Lin 2001, Xie and Wu 2008, Xie *et al.* 2009). Two benefits of state sector employment not previously studied may partially explain its protective effect for childhood overweight/obesity. As documented in existing research (Bian and Zhang 2001, Lin 2001, Bray 2005, Xie *et al.* 2009, state sector jobs are characterised by a more egalitarian welfare distribution, dense networks and adequate social capital (resources embedded in social networks) than other jobs, which may promote the flow of health knowledge. Network density within state sectors might also influence childhood overweight and obesity through social comparisons with similar others (Mueller *et al.* 2010). Unfortunately these possibilities cannot be tested because the CHNS lacks information about individuals' social networks and social capital. Another benefit of state-sector employment is that they have fewer health risks than non-state-sector jobs. Compared to state-sector employment, the latter include prolonged work hours, irregular working patterns and perhaps weakened parental-child ties in the face of more fierce market competition. These disadvantages of non-state-sector employment may also influence childhood overweight via proximate determinants, such as reduced breastfeeding, less parental intervention to regulate the content and regularity of children's diets, and less supervision of children's sedentary behaviors. Among these risk factors, hours spent watching TV, playing video games, using smart phones and internet browsing are particularly high among US children and adolescents (Danner 2008, Rideout *et al.* 2010) and may be increasing dramatically in China as well. These hypotheses about why working in the state-sector is beneficial can be only partially tested using CHNS data because of data limitations. Recent waves of the CHNS include information about parents' and children's nutritional knowledge and children's sedentary behaviors but only for adolescents.[2] The only weak evidence we observed is for adolescents aged 12–17 in the 2004 and 2006 waves of the CHNS who were asked about their knowledge of and attitudes toward diet and physical activity. Results indicated that adolescents' attitudes towards sports participation and their body images accounted for a small proportion of the relationship between parental state-sector employment and adolescent overweight/obesity.

We were able to examine one potential pathway by which state sector employment might protect against childhood overweight/obesity. Parents working in state sector jobs may be

[2]We found that parental nutrition knowledge (e.g. knowledge about the health outcomes of consuming sugar, fresh fruits and vegetables, staple foods, fatty meat, physical activity, and so on) collected in the 2004 and 2006 CHNS failed to explain the effect of parental state sector. We also found that the effect of parental state sector was not explained by children's sedentary behaviours (such as watching TV and playing video games) or parents' reports of the importance of children's exercise and diet (results not shown).

more likely to have only one child than workers in other employment sectors. Because parents with state sector jobs are under the direct surveillance of family planning officials and family planning policies were more strictly enforced in state sectors (Bongaarts and Greenhalgh 1985, the only child of parents working in state sectors might receive more attention and care, including more supervision of dietary and sedentary behaviours, than children with siblings (Short *et al.* 2001). However, an auxiliary analysis showed that the protective effect of parental state-sector employment on childhood overweight/obesity remained the same when children without siblings were compared to those with siblings. Results from previous studies and auxiliary analyses tend to suggest the existence of multiple pathways through which parental state-sector employment can influence childhood overweight/obesity.

Two theoretical frameworks laid the foundation for this study. Fundamental cause theory sets the stage for understanding the robust relationships between socioeconomic determinants and health outcomes and risks. Market transformation theory provided insight about recent economic, social, and cultural changes in China and the identification of culture-specific indicators of stratification. The results of this study provide modest support for both theories and demonstrate the importance of both for understanding the antecedents of childhood overweight/ obesity in China.

The larger lesson with regard to fundamental cause theory is that while conventional SES indicators may be nearly universally associated with health and health risks, relevant socioeconomic determinants differ across time and space. The classical wisdom of Weber and Marx reminds us that social stratification rests firmly on power. Although education and income may capture power well, or at least adequately, in developed countries, they may not be adequate indicators of power in other societies. In China, despite massive economic changes, the work-unit system as a principal source of social inequality deserves serious attention from medical sociologists. Likewise, while the persistence of power in (post-)socialist societies has been thoroughly investigated in terms of income, housing and welfare provision (Walder 1986, Zhou 2000, Bray 2005, Xie *et al.* 2009, it is worthwhile for students of stratification to explore the possible implications of political power on health outcomes.

Our research is not without limitations. First, our relatively small sample size does not allow detailed comparisons across parental occupational categories, which is important for a comprehensive examination of SES gradients in childhood overweight/obesity. Likewise, we cannot explore the socioeconomic determinants of childhood overweight/obesity separately for rural and urban areas due to limited sample size. Although results from a single statistical method are subject to specific assumptions, our results, based on different methods and measures of childhood overweight/obesity, strongly suggest that parental state-sector employment has become a protective factor for childhood overweight and obesity in China. These findings reinforce the value of continuing research into the socioeconomic determinants of childhood overweight/ obesity and the nature of social stratification in reform-era China, especially from market transformation perspectives.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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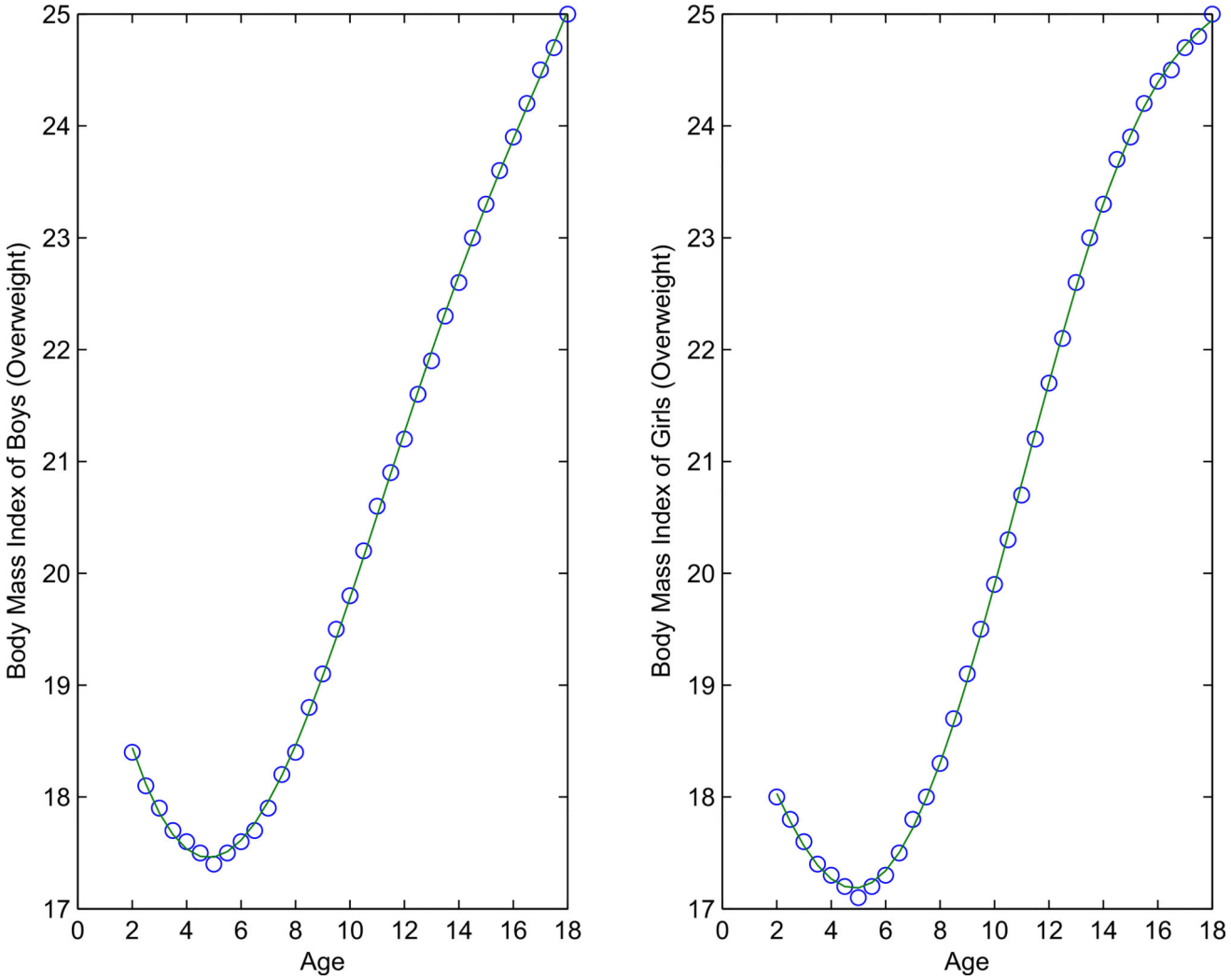

Figure 1.

Fitting the IOTF age– and sex–specific cut–points by a polynomial method ($R^2 > 0.9999$ and the sum of squared residuals <0.07 for both figures)

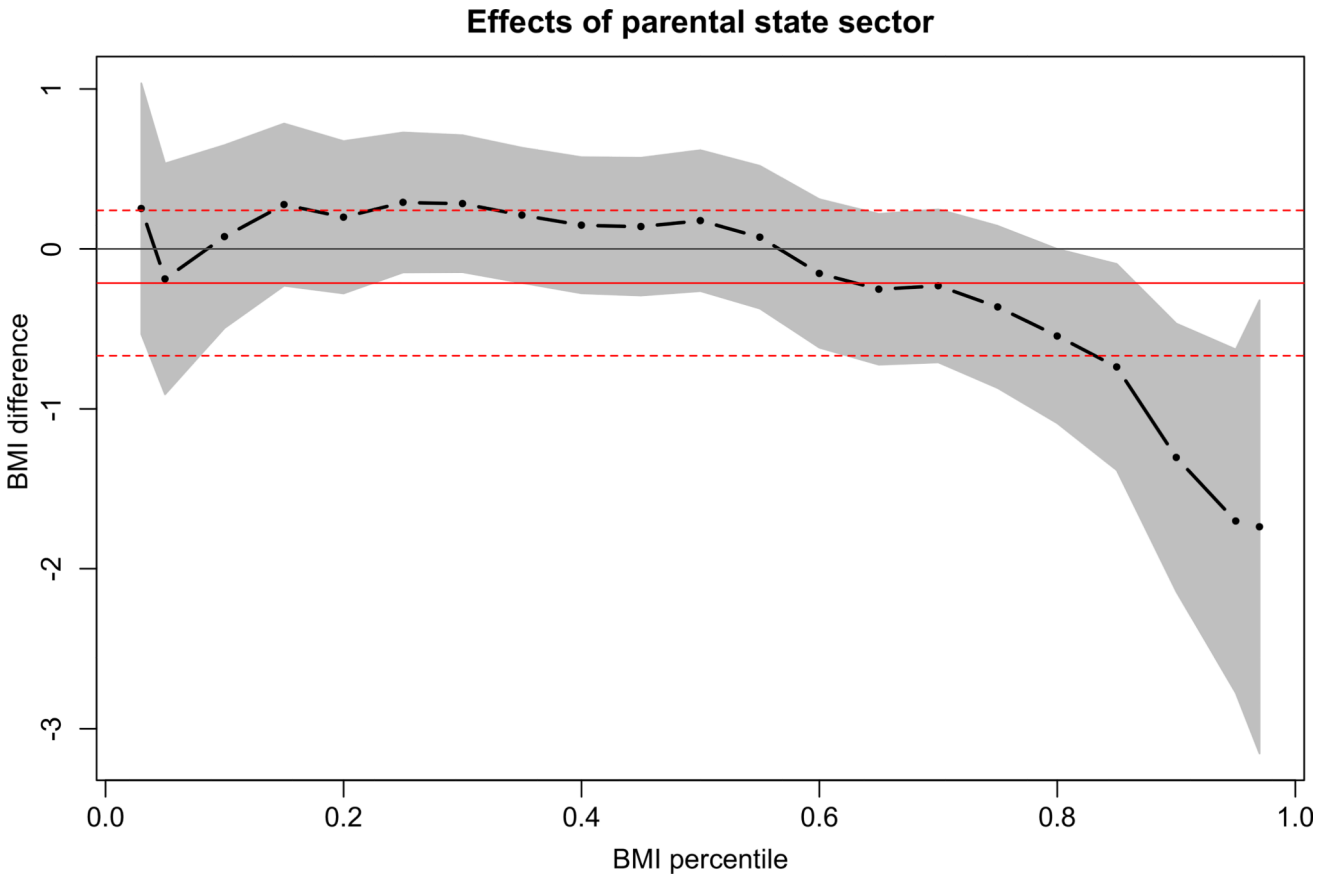

Figure 2.

Coefficients of parental state sector and their 95% confidence bounds across children's BMI percentiles in 2006: quantile regression [abc]Notes: [a]This quantile regression model is based on asymptotic estimation for specific BMI percentiles (0.05–0.95 quintiles and 0.03 and 0.97 percentile). This pattern reported remains robust using kernel density estimation and bootstrap estimation. [b] Sex, (high order terms of) age, parental age, parental BMI, rural residency, family structure, regions and other Socioeconomic determinants (per capita household income, parental tertiary education and parental administrative job) have been controlled for. [c] Ordinary least squares (OLS) coefficients are marked by solid horizontal lines and 95% confidence intervals are marked by dashed lines.

Table 1

Characteristics of surveyed Chinese children aged 1–18 years across waves

	1997		2000		2004		2006	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Dependent variables:								
BMI (kg/ m^2)	17.0	2.7	17.3	2.8	17.4	2.8	17.3	2.9
Overweight (%)	6.5		7.3		8.9		11.3	
Demographic and anthropometric characteristics:								
Age (years)	10.6	4.1	11.2	4.1	10.7	4.6	10.1	4.6
Male (%)	52.6		53.6		53.7		52.9	
Number of children in a household (persons)	1.9	0.8	1.7	0.7	1.5	0.7	1.5	0.7
Multi-generational households (%)	23.4		23.8		33.2		40.7	
Living in a two-parent household (%)	96.5		95.9		86.7		87.8	
Parental age (years)	36.6	7.4	33.6	9.8	34.4	9.1	34.0	9.1
Parental BMI (kg/ m2)	19.4	6.0	19.8	5.6	19.6	6.0	19.8	6.5
Regional disparity:								
Rural residency (urban residency as reference) (%)	72.1		74.0		72.8		73.1	
Coastal regions (western regions as reference) (%)	29.5		36.6		37.4		38.7	
Middle regions (western regions as reference) (%)	39.9		33.6		29.8		28.3	
Southern regions (northern regions as reference) (%)	67.0		60.7		62.4		59.9	
Socioeconomic determinants								
Per capita household income (1,000 *yuan*)	3.7	3.0	4.7	4.4	6.2	6.0	6.9	7.3
Parental years of schooling (years)	6.9	3.1	7.5	3.0	7.7	3.1	7.9	3.2
Parental administrative job (%)	11.2		10.2		10.1		10.6	
Parental state sector (%)	17.3		18.1		19.8		18.7	
Number of cases	2,556		2,063		1,431		1,242	

Table 2

Logistic (longitudinal) analyses of overweight among individuals aged 1–18 years: 1997 to 2006

	The 1997 Wave (N = 2556)		The 2000 Wave (N = 2063)		The 2004 Wave (N = 1431)		The 2006 Wave (N = 1242)		Pooled sample (N = 7292)	
	Coeff.	S.E.[a]	Coeff.	S.E.[a]	Coeff.	S.E.[a]	Coeff.	S.E.[a]	Coeff.	S.E.[a]
Demographic and anthropometric characteristics:										
Age	−0.143	0.084†	−0.332	0.086***	−0.012	0.092	0.026	0.088	−0.182	0.057**
Age^2	0.002	0.004	0.011	0.004*	−0.006	0.005	−0.008	0.005	0.001	0.003
Male	0.343	0.172*	0.389	0.184*	−0.095	0.190	−0.004	0.188	0.184	0.136
Number of children in a household	−0.017	0.127	−0.173	0.152	−0.053	0.172	−0.133	0.181	−0.166	0.104
Multi–generational households	0.390	0.190*	−0.212	0.220	−0.032	0.212	−0.136	0.202	0.044	0.151
Living in a two–parent household	0.144	0.680	−0.208	0.466	0.114	0.557	−0.364	0.459	0.055	0.323
Parental age	−0.014	0.018	−0.032	0.018†	0.014	0.019	0.002	0.019	−0.012	0.011
Parental BMI	0.058	0.019**	0.067	0.028*	0.029	0.023	0.028	0.019	0.042	0.014**
Regional disparity:										
Rural residency (urban residency as reference)	−0.089	0.194	−0.348	0.214	−0.329	0.217	−0.213	0.217	−0.296	0.159†
Coastal regions (western regions as reference)	0.756	0.286**	0.352	0.329	0.759	0.333*	1.207	0.339***	1.002	0.234***
Middle regions (western regions as reference)	0.178	0.269	0.216	0.304	0.494	0.297†	1.029	0.301**	0.518	0.208*
Southern regions (northern regions as reference)	−0.536	0.203**	−0.786	0.236**	−0.207	0.239	0.067	0.238	−0.596	0.170***
Survey years (the 1997 wave as reference):										
The 2000 wave									0.259	0.177
The 2004 wave									0.459	0.200*
The 2006 wave									0.877	0.201***
Socioeconomic determinants										
Per capita household income	−0.010	0.032	0.031	0.015*	−0.004	0.017	0.011	0.012	0.018	0.011
Parental years of schooling	0.040	0.033	−0.015	0.037	0.025	0.044	0.060	0.043	0.037	0.027
Parental administrative job	0.104	0.246	0.414	0.289	0.079	0.314	0.541	0.345	0.271	0.203
Parental state sector	0.490	0.221*	0.004	0.264	0.033	0.268	−1.055	0.345**	0.460	0.265†
Parental state sector × the 2000 wave									−0.518	0.350

	The 1997 Wave (N = 2556)		The 2000 Wave (N = 2063)		The 2004 Wave (N = 1431)		The 2006 Wave (N = 1242)		Pooled sample (N = 7292)	
	Coeff.	**S.E.*a***	**Coeff.**	**S.E.*a***	**Coeff.**	**S.E.*a***	**Coeff.**	**S.E.*a***	**Coeff.**	**S.E.*a***
Parental state sector × the 2004 wave									−0.525	0.381
Parental state sector × the 2006 wave									−1.359	0.423***
Constant	−2.959	0.842***	−0.216	0.729	−2.916	0.789***	−2.751	0.738***	−3.138	0.534***
Pseudo R^2 *b*	0.111		0.118		0.067		0.085		0.530	
Log likelihood	−543.8		−476.4		−402.2		−400.3		−1788.4	

Notes:

*a*Statistical significance:

†$p < 0.10$;

*$p < 0.05$;

**$p < 0.01$;

***$p < 0.001$ (two–tailed tests).

*b*The intra–class correlation coefficient instead of pseudo R^2 is shown for the pooled sample.