Did the One-Child Policy Generate Child Overweight in China in the 1990s? A Cross-Sectional and Longitudinal Analysis

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Abstract

The prevalence of overweight among children in China has increased, and the one-child policy has been suggested as a cause. Drawing on longitudinal data from the 1993, 1997 and 2000 waves of the China Health and Nutrition Survey, this analysis investigates the relationship between the one-child policy and overweight among young children. The policy is measured directly as policy strength and indirectly as sibship composition. Cross-sectional and longitudinal findings from multilevel models suggest that, first, overweight among preschoolers and primary school children increased in the 1990s at a slower pace than that documented in previous studies in China. Second, single children and those in strong policy communities do not differ from children with sibling(s) and those in weak policy communities, after adjusting for household and community characteristics. Thus, the policy does not seem to bear a relationship to child overweight risk directly or indirectly, and little evidence has emerged from this analysis to support the public perception that the one-child policy is associated with the rising epidemic of child overweight in transitional China.

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Introduction

Obesity has become a serious public health concern worldwide. Child obesity has recently received particular attention, as its relation to health problems in the later stage of life has been elaborated (Darnton-Hill and Coyne 1998; WHO 1998). In the process of modernization in, and the penetration of globalization to, developing countries, obesity is no longer a luxury unique to industrialized societies. Although relatively rare compared with developed countries such as the US and western European nations, the prevalence of child obesity in developing countries is growing at a faster pace than ever before along with rising wealth and increasing food availability.

China is among the nations that face a rapid increase in obesity (e.g., Chen 2000), although the prevalence remains relatively low (7.7 percent in 1997) compared with other countries, such as Brazil (14 percent in 1997) and the US (26 percent in 1994) (Wang, Monteiro and Popkin 2002). The rising epidemic of obesity in China, as in other developing countries, reflects profound changes in society and in behavioral patterns of the population in recent years (Popkin 2001). The economic reform initiated in 1978 and the subsequent economic growth have more than doubled per capita income in urban areas and tripled it in the countryside during the 1980s. Food is no longer a problem for the majority of Chinese population (Smil 1985, 1995) and the nutritional energy has increased markedly. Improved food availability, together with modernization, urbanization, globalization of food markets, sedentary lifestyle and cultural norms toward body image, becomes one of the forces underlying the rapid increase of obesity among young children and adolescents (Chen 2000; Popkin 2001).

The primary interest of this study is, however, to examine whether the one-child policy has played a role, directly and/or indirectly, in the rising epidemic of child obesity. This family planning program, perhaps the most effective yet most controversial known to date in human history, has often been suggested as the cause of the increasing number of "*xiao pang dun*" ("little fat kids"), despite the fact that the policy has also aimed to improve child health. Under the one-child policy regime, each household has few children. Each child, often described as the "little emperor" or "little sun," has increasingly become the center of attention in the household and has become more precious than ever to parents. As a result, parents tend to spoil their children by feeding them more and better food, which means a greater consumption of high-fat diets in the Chinese context. Meanwhile, many children live with grandparents who tend to overfeed grandchildren, especially boys. The one-child policy often means that there are four grandparents to one child, all of them competing to feed him/her. In addition, Chinese children are expected to shoulder the responsibility of family fame and of realizing parental dreams. Under the low fertility regime, parental expectations and aspirations now rest on the few or only children, who, with all household resources invested in them, tend to be over-nourished. Consequently, "Chinese kids [are] getting fatter under one child policy (Taylor 2004), and "[an] only child born under the one-child policy is more likely to be overweight [than sibling children]" (Ni 2000).

Twenty-five years after the onset of the one-child policy, however, there is essentially no study examining the policy-obesity linkage with the exception of Hesketh et al. (2003), who used sibsize (i.e., number of siblings) as a proxy of the policy and found no difference between single children and non-single children. Nevertheless, the so-called one-child policy does not always mandate one child per couple. Instead, the policy rules have profound local variations, generally in the form of exceptions. Under normal circumstances, couples may be allowed to have only one child, two or more children or a second birth if the first child is a daughter, in addition to many other exceptions. To what extent does the one-child policy affect child obesity? Are local variations in policy rules related to the rising epidemic of child obesity? Is the policy related to child obesity through sibship composition (sibsize, sibling interval, order and gender)? Is the alleged policy-obesity causal relation a function of other factors such as socioeconomic development?

This paper investigates the relationship between the one-child policy and the risk of child overweight among young children in the 1990s. Given the markedly reduced family size due to the one-child policy, an ideology associated with the policy campaigns that highlights child health (defined as being free of malnutrition and diseases), and the rising household wealth (due to economic development and smaller family size), we might predict that the risk of child overweight would be more common among single children and children in strong policy communities in the long run.

Specifically, drawing on data from multiple waves of the China Health and Nutrition Survey (CHNS), it describes the trends and patterns of child overweight in the survey areas. Then, a cross-sectional analysis is conducted to examine the overweight risk among primary school children (age 7-12) in 2000. Finally, a longitudinal analysis is carried out to explore the determinants of the time trend of child overweight status in 1993, 1997 and 2000 by focusing on children age 0-5 at baseline (1993) who followed up in the 1997 and/or 2000 survey. A particular strength of this paper is the use of the CHNS data, which includes substantial information on anthropometric measures, a broad range of factors at the individual and household levels as well as a community instrument. Community information enables me to explore the role of contextual factors, especially the local variations of the one-child policy, in child overweight risk. To my knowledge, this is the first empirical study of the consequences of the one-child policy on child overweight risk over time that includes direct policy measures. Focusing on socioeconomic characteristics and contextual dynamics, this study also complements existing public health and epidemiological analyses of children's lives in contemporary China (Wang, Ge and Popkin 2000; Wang, Bentley, Zhai and Popkin 2002; Wang, Monteiro and Popkin 2002; Wang, Popkin and Zhai 1998).

One-child policy, sibship composition and child overweight

The one-child policy has evolved from earlier family planning programs. The current policy promotes (1) later marriage and childbearing, and (2) one child per couple. However, the term of "one-child per couple policy" is misleading since it allows locally interpreted variations regarding having a second birth for a "small number of families" (Peng 1997:498), although the exception is implemented much more widely than originally intended. According to the National Population and Family Planning Commission of China, six provinces and the rural regions of Tibetan Autonomous Regions implement a two-or-more-child policy; seven provinces and three provincial-level cities implement the strict one-child policy under normal circumstances; and 17 provinces have a daughter-exception policy in the countryside (Zhang and Chen 1999). Thus, the implementation of the so-called one-child policy varies across regions, depending largely upon the local economic structure. Hence, whereas couples in some communities are limited to one child, couples in other communities may be allowed to have either two children or a second birth if the first child is a girl, provided that a four-year interval between the two births is observed (Peng 1997). Two variations under normal circumstances[1] are a girl-exception policy and a two-child policy. Together with the strict one-child policy, they can be termed as strong, moderate and weak, respectively (Short et al. 2001).

The implication of diverse policy rules for fertility at the household level is that they generate different sibship composition (i.e., sibsize, sibling order, interval and gender). Table 1 describes the relationship between the one-child policy rules and sibship composition for children age 7-12 based upon a preliminary analysis of the 2000 CHNS. Sibship is specified as sibsize; but for those with only 1 sibling, I also differentiate the sibling by gender, order or interval. The percentage of single children in strong policy communities is twice that of weak policy communities (44 vs. 19 percent). Conversely, strong policy communities have a much lower percentage of children with 2 or more siblings (17 vs. 32 percent). Similarly, a lower percentage of children in strong policy communities have a sibling compared to children in weak policy communities, regardless of sibling gender, order or density except for those with a wide spacing. There are more girls in strong policy communities than other communities.

[Table 1 about here]

Sibship composition shapes the amount of resources that can be distributed to each child within a household. More siblings, a shorter birth interval between adjacent siblings, and the addition of a higher parity sibling all dilute household resources, leading to a lower child outcome. In contrast, children garnering more resources excel in status outcomes such as education (Blake 1981; Powell and Steelman 1990, 1995; Steelman et al. 2002). Thus, children with more siblings, a closely spaced or a high parity sibling are found to have lower educational opportunities (Blake 1981; Steelman et al. 2002).

[1] "Normal circumstance" is widely defined, such as the couple is Han ethnicity (the majority), not from overseas, has sibling(s); children do not have health problems (broadly defined); etc.

Empirical studies on child overweight have documented that single children are prone to obesity in Thailand (Chamratrithirong et al. 1987) and many other countries (Parsons et al. 1999), but do not differ from sibling children in China (Hesketh et al. 2003). The prevalence of child obesity also varies by sex: 20 percent for boys and 15 percent for girls in China (Meng 1995), for example. The gender pattern of obesity in China differs from that in other developing countries (e.g., Sub-Saharan countries) where girls commonly have a higher risk of obesity than boys (Florencio et al. 2001; Martorell et al. 2000; Mokhtar et al. 2001).

Individual-level correlates of obesity are intertwined with household and macro-level factors, including rising wealth and increasing availability of food at the national and household levels, dietary structure, behavioral patterns and urbanization, as well as cultural norms regarding body image (Chen 2000; Mokhtar et al. 2001; Popkin 1993; Popkin et al. 1995; Sobal and Stunkard 1989). The income-diet relationship translates directly into an income-obesity relationship for adults and children (Popkin et al. 1995). Studies have invariably found that children from households with a higher SES have a higher risk of obesity and there is a well-documented, consistent, and positive relationship between income and obesity across developing countries and cultures (Arteaga et al. 1983; Caballero 2001; Nelson 1994; Owen et al. 1981; Ravussin et al. 1994). Mother's education and parental Body Mass Index (BMI) are also positively associated with a child's risk of overweight or obesity in developing countries, including China (Luo and Hu 2003; Martorell et al. 2000; Wang, Bentley, Zhai and Popkin 2002). Furthermore, obesity is more common among urban children in both absolute numbers and the rate of increase worldwide (Lopez-Blanco et al. 1992; Martorell et al. 2000; WHO 1997), and China is no exception (Chen 2000). For example, the prevalence of obesity among children age 6 to 12 in Beijing rose from 11 percent in 1990 to 17 percent in 1993 (Meng 1995).

Similarly, in Heilongjiang province, 5 percent of urban school students were obese in 1991, and this figure rose to 6 percent in 1992 and 15 percent in 1993 (Liu and Yuan 1995, cited in Wang, Popkin and Zhai 1998).

This brief review suggests that the relationship between the one-child policy and the risk of child obesity should be examined in more detail with direct measures of the one-child policy. This paper focuses on the variations of policy strength/rules and sibship composition, and investigates the role that the policy may play in the escalating overweight epidemic among young children in China.

Data and methods

Sample

The data come from multiple waves of the China Health and Nutrition Survey (CHNS). The survey is conducted in nine provinces, including, from northeast to southwest, Heilongjiang, Liaoning, Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou. The sample within each province is drawn using a multistage, random cluster process. While these provinces are non-randomly selected, they host 45 percent of China's total population and reflect substantial demographic and socioeconomic variation; their average characteristics are also comparable to the national average in many instances (e.g., Short et al. 2000). The CHNS is a panel survey, conducted five times between 1989 and 2000, and this study uses data from the 1993, 1997 and 2000 survey. The 1993 survey draws a sample from eight provinces (without Heilongjiang), but Liaoning is replaced by Heilongjiang in the 1997 survey, while the 2000 survey contains all nine provinces.

Variables

Dependent variable. The dependent variable is the overweight risk among preschoolers and primary school children. This analysis focuses on young children because of the low incidence of overweight among adolescents. It focuses on overweight because of the low incidence of obesity in the sample – only 4 percent of children are obese in the 2000 sample among those 7-12, for example.[2] Defining overweight for children is difficult due to different rates of maturation and growth, and there is no generally accepted standard of overweight for children. A variety of criteria have been used, making comparisons between studies difficult (BMJ 2000). This study uses the age- and sex- specific cutoff point based on the standard set by Cole et al. (2000). This standard might be more appropriate for Chinese children because it is based on the growth rate of children from six countries or regions including Singapore and Hong Kong (as well as Brazil, Netherlands, United Kingdom, and United States). Since Cole et al. (2000) do not provide a cutoff point for children younger than 2, I apply the weight-for-height Z-score recommended by the WHO Expert Committee (1995:195) to them, defining those with a Z score ≥ 2 as overweight (97.7th percentiles),[3] a cutoff point specifically recommended to measure overweight for infants and children.

Independent variables. To investigate the policy-overweight relationship, I capitalize on variations in the one-child policy across communities. The community survey of the CHNS

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[2] This figure differs from studies cited above (e.g., Chen 2000; Liu and Yuan 1995; Meng 1995). The discrepancy might be related to the diverse cut-off points of overweight/obesity and different study population.

[3] One potential caveat is that this study adopts two different standards of overweight for different ages of children. Cole et al. (2000)'s standard is based on a pooled sample from different countries, while the WHZ is based on American children. They may not be compatible.

However, previous studies comparing WHO and Cole et al's standards for children age 6+ have found that generally they produce similar estimates of the overall prevalence of overweight, although there are considerable differences between the 2 references for some age groups (Wang, Monteiro and Popkin 2002; Wang and Wang et al. 2000; Wang and Wang 2002). Hence, I assume that adopting the two standards will not bias parameter estimates. Even if bias exists, it is likely to underestimate the overweight risk for those age 0-1 because 97.7th percentile is a conservative measure, relative to some other measures (e.g., 85th percentile for overweight).

asks local cadres if couples in their communities are allowed to have only one child, two children, or a second birth if the first child is a daughter, among other exceptions under normal circumstances. This study highlights two exceptions – a second birth or two children. They are particularly relevant to this study because they shape sibship composition within households, and are likely a reasonable indicator of local policy climate. Using these exceptions, I distinguish three levels of policy strength: *one-child policy* (strong), *girl-exception policy* (moderate), and *two-child policy* (weak).

Policy may also affect overweight risk through sibship composition. Sibship composition is conventionally measured as sibsize, sibling order, interval and gender. However, due to the peculiar one-child policy, most Chinese children are either the first or the last, and most urban children are both the first and the last. Thus, sibship is measured as sibsize (0, 1 or 2+). For those with only one sibling I also differentiate the sibling by gender, order and interval, respectively: a brother/sister, an older/younger sibling, or a closely/widely spaced sibling. Child gender might be also affected by the policy in a sense that policy per se is a gendered policy (given the girl exception) and that a pregnant woman may choose not to keep the fetus of an undesired sex. Hence, child gender is included as a key predictor.

<u>Control variables.</u>[4] To assess the net effect of the policy on the overweight risk, I control for child age, mother's education, parental BMI, household wealth, local development level, urban residence and province. Since the three waves of the survey have non-identical survey intervals, survey year is included as a covariate to adjust for the possibly biased findings due to the unequal interval. It may also capture period effect on overweight.

[4] In addition, I have also explored the relationship between the overweight risk and one-child subsidy, family planning responsibility system (which is a method adopted to effectively implement the one-child policy), Han ethnicity, mother's occupation and grandparents nearby. They are unrelated to overweight, all else equal; nor do they modify other covariates' effect on the outcome variable. I thus do not include them in the final models for the purpose of parsimony.

The definition of all variables used in this analysis is presented in Table 2.

[Table 2 about here]

Trends and patterns of overweight among young children in the CHNS areas

Figure 1 depicts the trend of overweight in the CHNS areas in the 1990s by age cohort. Overall, the prevalence of overweight rises overtime, although the rate of increase is relatively low, ranging from 22 to 24 percent and 11 to 12 percent for the cohorts age 0-5 and age 7-12, respectively. The prevalence of overweight among preschoolers is twice that of primary school children. There is a drop in overweight prevalence in 1997 for the younger cohort, but it remains relatively stable overtime for the older cohort.

[Figure 1 about here]

How are the one-child policy and sibship composition related to the overweight risk? Figures 2 illustrates the patterns of overweight by age cohort, sibsize and policy strength. For the younger cohort (age 0-5), the difference in overweight status between single children and non-single children, and between children in strong policy communities and those in moderate or weak policy communities is not salient. For the older cohort, however, single children and those in strong policy communities clearly have a higher incidence of overweight than non-single children and their peers in moderate and weak policy communities. This suggests that policy may be more related to the overweight risk of older children than younger children directly and indirectly, and that overweight is not entirely biologically determined. These patterns hold when the sample is stratified by urban residence, indicated by Figure 3, which is for the 2000 cross-sectional sample. The only exception is for urban single children who have a slightly lower percentage of overweight than children with sibling(s).

[Figure 2 and Figure 3 about here]

The bivariate analysis between the one-child policy and overweight based on the 1993 and/or 2000 CHNS suggests a connection between the policy (direct and indirect) and overweight. However, will this relationship be confounded by non-policy factors? To explore this issue further, I now turn to regression models, controlling for individual, household and contextual characteristics.

Analytical approach

To better understand the relationship between the one-child policy and overweight risk among young children in the 1990s, I adopt a two-step strategy. First, I conduct a cross-sectional analysis of the overweight risk among children age 7-12 in 2000. This analysis is necessary for two reasons. First, because of the non-random sample attrition in the longitudinal analysis (see below), its findings provide a pattern of the policy-overweight relationship at one point in time, and can be compared with results from the panel analysis to ascertain whether and how the longitudinal findings might be biased. Second, given the relatively small sample size and lower incidence of overweight, this analysis maximizes observations and thus increases the power of the analysis. It adopts a lagged cross-sectional design, using the 1993 community policy characteristics to predict the overweight risk in 2000, and it includes all children in this age range with valid information (N=1077).

As the second step, I make use of a longitudinal design by exploring dynamically the time trend of overweight risk in 1993, 1997 and 2000. It adopts a repeated measure design, and highlights *historical changes* in context. China is undergoing tremendous changes. The one-child policy and sibship composition also change over time. How might contextual and household variability be related to child overweight risk over time? We attempt to address this issue here. All children with valid information at baseline, and those who were followed up in 1997 and/or 2000 are included in the sample (total observations=2034). It is important to note that a significant part of the sample was lost to follow-up – of the 940 children in 1993, 386 (41 percent) are measured three times, 312 (33 percent) twice, and 247 (26 percent) only once. An attrition test suggests a non-random sample dropout – those who dropped out tend to be only children, younger, live in two-child policy communities, urban setting and live in Liaoning, Shandong and Henan. However, this does not necessarily invalidate the findings of this study because, as I demonstrate next, results from the cross-sectional and longitudinal analyses are consistent. In addition, high level of loss to follow-up in panel design is not unique to this analysis. Other studies using the same dataset also encounter systematic dropouts (e.g., Chen 2005, upcoming). And according to findings from the Michigan Panel Study on Income Dynamics, inferential statistics were not affected despite a 50 percent of cumulative sample dropout (Fitzgerald, Gottschalk, and Moffitt 1998).

Table 3 summarizes the proportion or means and standard deviations, as appropriate, for the sample of cross-sectional analysis of child overweight in 2000 among children age 7-12, as well as the baseline information of the sample of the time trend analysis. Direct comparison of the characteristics of the two samples is inappropriate because samples do not necessarily contain the same children. In the cross-sectional analysis, for example, 11 percent of children are overweight. One-third are single children and one-fifth have 2+ siblings. Less than half of the sample (45 percent) is girls. Some 46 percent of communities implement a strong policy, one-third a moderate policy and the rest a weak policy.

[Table 3 about here]

Since the dependent variable, the overweight risk, is dichotomously constructed, binary models apply. However, due to the nested nature of the CHNS data, observations within each community and observations within each household are not independent. The lack of independence violates the basic assumption of statistics (i.e., independence of errors), and conventional techniques may yield biased results (Guo and Zhao 2000). Failure to account for the level of dependence, even if it is modest, "would have led to an erroneous conclusion about the impact of individual-level covariates" (Teachman and Crowder 2002:290). By contrast, multilevel models are more appropriate methods of analysis as residual variation can be taken into account (and quantified) at both the individual and community levels, allowing the effects of context to be separated from the effects of composition (Diez 2000; Duncan et al. 1998; Greenland 2000; Pickett and Pearl 2001; Singer 1998; Von Korff et al. 1992). Thus, the model strategy is to fit multilevel models in which community is treated as an upper level unit.

Analytic results

While conceptually and methodologically, a multilevel modeling technique is the ideal technique for this analysis, whether or not multilevel models are necessary depends upon the importance of upper-level random effect to the outcome variable. So, before proceeding to analyze the policy-overweight relation, two-level unconditional means models are first fitted – individuals at level 1 and communities at level 2.[5] Results (Appendix 1, Panel A for cross-

[5] Since the data have a four-level structure, province, community, household and individual children, corresponding models should be fitted. However, there are too few provinces for them to be identified as an independent level (Hox 1998). Clustering at the household level is also low. The 940 children at baseline for the longitudinal analysis, for example, are from 777 households, and 82 percent (637 households) have only one sample, suggesting that it is unnecessary to include households as an independent level. The low clustering issue also exists in cross-sectional analysis. Hence, province and household are not be modeled as separate levels.

Recent advancement in multilevel modeling technique makes it possible to model observations nested within each individual as an independent level. For the time trend analysis, therefore, I have also attempted to fit a three-level sectional analysis and Panel B for longitudinal analysis) show that the variance of the community random variable is highly significant for both the cross-sectional and longitudinal analyses. This suggests that there are significant differences in the proportion of overweight across communities over time and at one point in time, and that including the community-level variance will improve model fit. Therefore, in the analysis below, two-level models are applied, using MLwiN software (Version 2.1) (Rasbash et al. 2002) with the first order marginal quasilikelihood (MQL) method. One-child policy variables, percent of the labor force in agriculture, residence and provinces are variables at the community level in my study, whereas they are assigned to individuals in single level models.

Results presented here are from two-level random intercept models, which examine variations across communities in both the average likelihood of overweight and the effects of covariates on individual overweight risk. This model relaxes the constraint that the variation in overweight across communities is equal to 0, but allows the intercept to vary across communities. Nevertheless, all regression slopes are assumed to be fixed across communities and there are no cross-level interactions.[6]

Step 1. Cross-sectional analysis of overweight risk among children age 7-12 in 2000

The first analysis is cross-sectional, estimating the risk of overweight among children age 7-12 in 2000 using the 1993 policy characteristics and other information from the 2000

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unconditional means model – observation at level 1, individual at level 2 and community at level 3. Results (not shown here) show that the within-individual random variance is not significant. Thus, it is unnecessary to treat observations at multiple times as an independent level in this analysis. The lack of significance is not necessarily surprising, however, because, as aforementioned, 26 percent (247 children) of the 940 children at baseline are measured only once, mitigating the necessity of including within-individual random variable in the model.

[6] I also fit models with both random intercept and random slope, allowing sibsize varying across context. Results (not shown here) indicate that none of the random effects of sibship composition variables is significant. Nor does it significantly modify other covariates' effect on the response variable.

survey. While single children and those in strong policy communities have a higher prevalence of overweight than children with sibling(s) and their peers in weak policy communities in bivariate analysis, the indirect and direct policy effect is modified by other covariates. In Model 1 (Table 4), single children do not significantly differ from non-single children in the overweight risk. This result is consistent with previous studies (Hesketh et al. 2003). However, contrary to existing findings (e.g., Meng 1995), this analysis finds no gender difference in overweight; boys are just as healthy as girls in my sample. Similarly, policy strength is unrelated to the response variable – children in strong policy communities do not suffer more from overweight than their peers otherwise. Thus, findings from this analysis do not provide evidence to support the public perception on the policy-overweight linkage; on the contrary, I find that the one-child policy neither directly (policy rules) nor indirectly (sibship composition) relates to child overweight risk in this lagged cross-sectional analysis,[7] all else equal.

[Table 4 about here]

Although policy does not seem to bear a relationship to overweight risk, some control variables do influence this outcome. For example, parental BMI is positively related to the outcome variable – children with overweight parents have a higher overweight risk.[8] At the

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[7] Parallel models where sibship composition is specified as (a) single vs. non-single children, (b) number of sibling (0, 1 or 2+), (c) single child, 1 older sibling, 1 younger sibling or 2+ siblings, and (d) single child, 1 closely spaced sibling, 1 widely spaced sibling or 2+ siblings yield a similar pattern – sibship bears no effect on child overweight risk.

A model using 2000 policy characteristics is also fitted for the purpose of comparison. The result is similar to Model 1.

[8] Parental BMI is measured currently. Since parental BMI prior to the birth of the index child is unavailable, it may not be a good measure of genetic factor. Nevertheless, it might reflect current household lifestyle and environment such as diets and activities, which is also informative for children's overweight risk.

However, parental BMI and child overweight might be endogenous. It is possible that household wealth (and/or other factors) causes both overweight parents and children. Nonetheless, models with or without this covariate yield similar findings, and thus, all else equal, parental BMI does not modify other factors' effect on the overweight risk, and its effect is additive.

community level, urban children are marginally more likely to suffer from overweight than their rural counterparts. Province is the strongest predictor of this outcome, and children in Shandong (a province in northeast China) have the highest risk of overweight.

There is tremendous socioeconomic stratification between the countryside and urban settings; the bivariate statistics indicate that urban children and rural children differ in the risk of overweight, and Model 1 suggests that urban children have a significantly higher risk of overweight than their rural peers. Thus, it is reasonable to believe that covariates may work differently for urban and rural children. Similarly, previous studies have suggested that the local variations of the one-child policy may not only affect who becomes a family member, but also the degree to which given children in a family are valued (Short et al. 2001). Therefore, the effect of covariates on child overweight risk may also vary by child gender. Hence, a natural next step of this analysis might be to run fully interactive models between urban residence and covariates, as well as between child gender and covariates. However, due to the small sample size of urban children and by child gender, and thereby the low power of the analysis, interactive models between urban residence/girls and policy are fitted instead. Results suggest that only the model with interactions between urban and sibship composition has an improved model fit, and sibship effect on overweight varies by urban residence (Model 2 in Table 4). Surprisingly, urban children with 1 sister are more likely to be overweight than single children.[9] It might be that urban single children are more selective in food, leading to a lower risk of overweight. Thus, although there are reasons to expect the effect of policy rules on child

[9] A simple model where sibship composition is specified as single children, 1 sibling and 2+ siblings also shows that urban children with 1 sibling have a higher risk of overweight than urban single children. Similarly, findings from a model where sibsize is specified as single vs. non-single children indicate that urban non-single children suffer more in overweight than only children.

overweight risk to vary by urban residence and child gender, findings emerging from the nested model do not support this (Tables not shown).

Judging from the between-group variance, we see that some variability across communities in the likelihood of overweight is accounted for by contextual covariates. The community intercept components decreases notably in Model 1 relative to that in the unconditional means model. The reduced value indicates that 43 percent of explainable variation in the probability of overweight is accounted for by community covariates. Nevertheless, predictors do not explain all variance in the response variable and the unobserved latent random variable at the community level remains significant. Twenty-three percent of variance in the response variable can be partitioned to community-level variance.

The cross-sectional analysis shows that the one-child policy bears no effect on overweight risk among primary school children. All else equal, single children do not differ from those with siblings, and a strong policy does not differ from a weak policy in child overweight risk. Will this pattern sustain over time? This issue is addressed in the next section.

Step 2. Time trend analysis of overweight risk in 1993, 1997 and 2000

Now I proceed to the time trend analysis of overweight risk in 1993, 1997 and 2000. This analysis differs from the cross-sectional analysis because it takes advantage of the repeated panel design of data and takes into account historical changes in covariates. Table 5 lists the findings from two models: a model without interaction (Model 3) and a model with interaction between survey year and urban residence (Model 4). Results from the two models are consistent for the main effects except for survey year. As in the cross-sectional analysis, sibship composition (regardless of its specification) and one-child policy strength are unrelated to the time trend of the overweight risk in the 1990s. Although children with 2+ siblings and those residing in moderate and weak policy communities are less likely to be overweight than other children, the difference is not significant.

Significant predictors of the time trend of overweight risk include children's weight and height at baseline, children's age, mother's education, parental body mass index, local development level, and geographic location. As expected, baseline weight is positively, while baseline height is inversely, associated with the response variable. As children age, their overweight risk decreases. Mother's education is inversely linked to the outcome variable, but obese parents increase children's overweight risk. Among contextual factors, surprisingly, percent of the labor force in agriculture increases overweight risk, all else equal. Again, children in Shandong province have a higher overweight risk relative to their counterparts in other provinces.

[Table 5 about here]

Model 4 tests the interactions between time and urban residence. The model fit of the nested model is improved, judging from the -2 log likelihood statistics for the two models. A new finding is that children in the 1997 survey have a lower risk of overweight than they do in 1993, all else equal, suggesting a decline of overweight risk in 1997. However, urban children in 1997 and 2000 are more likely to be overweight than they are in 1993, and than their peers in the countryside in 1997 and 2000. It might suggest that overweight risk among urban children increases over time, which is similar to the pattern found by Luo and Hu (2003).[10]

The size of the between-community variance is reduced in these two models, relative to that of the unconditional means model (Appendix 1, Panel B). This indicates that covariates

[10] Interactive models between time and policy strength as well as between girls and policy are also fitted. Results are not presented because model fit of these nested models does not improve.

explain a proportion of variability in the response variable. However, level 2 variance remains a significant source of the variability in the time trend of overweight risk even if local development level, urban residence and regions are controlled for.

Discussion and conclusion

In the past two decades, China has witnessed a growing number of “little fat kids,” and the one-child policy has been suggested as a cause. Drawing on data from multiple waves of the China Health and Nutrition Survey, this paper has investigated the relationship between the one-child policy and child overweight risk among young children. Cross-sectional and longitudinal findings from multilevel models have offered new insights into the policy-overweight relationship, and insights into contextual factors that might affect the dynamics of child body weight status. First, the prevalence of overweight among preschoolers and primary school children increases in the 1990s, but the rate of increase is slower in the survey area than has been found in other studies in China. Also, the prevalence of overweight varies by age cohort and urban residence with younger and urban children a higher rate, but it does not seem to differ by child gender.

Second, this study shows that there are substantial crude differences between the strength of the one-child policy and overweight, as well as between sibship composition and overweight. Single children and those in strong policy communities have a higher incidence of overweight than their peers otherwise. However, there are minimal differences after adjusting for household and contextual characteristics in cross-sectional and longitudinal analyses. Only children appear as healthy as sibling children, which is consistent with Hesketh et al.’s (2003) finding; similarly, those in strong policy communities are no less healthy than their counterparts in moderate or weak policy communities. As such, this study finds no detrimental effect of being an only child or living in strong policy communities on health, and the policy bears neither a direct (local variations of policy strength) nor an indirect (sibship composition) association with child overweight risk, all else equal. Therefore, this study fails to provide evidence in support of the argument that the one-child policy caused the rising epidemic of child overweight.

Thus, although we would expect children living in a strong policy environment and single children to have a higher overweight risk than others, this analysis finds little support for this hypothesis. Then why, contrary to public perception, does policy seem to be unrelated to the risk of overweight among young children? Several factors may explain this. In order for a child to become overweight, it is necessary to both increase energy intake frequently (particularly high-fat food) and live a sedentary lifestyle (WHO 1997). In China, and other developing countries as well, overweight is a complicated phenomenon because traditional ideology towards body image conflicts with modern perception of health. Decades ago, most Chinese viewed plumpness as a sign of prosperity and robust health, whereas thinness was avoided at all costs since an emaciated body represents bad luck, illness, and early death (Watson 2000). Food shortages meant that overweight never emerged as a health problem until very recently – it was rare to see individuals who fit the modern clinical guidelines of overweight/obesity in China until the late 1980s. While with economic development, food availability is no longer a problem for the majority of Chinese population, the dietary structure, whilst changing, is still laden with grains and vegetables. High-fat food (e.g., meat) remains too expensive to consume in such quantities that may generate overweight. Although fast food from Western countries becomes increasingly common, it is mostly available in urban settings, and it is not a daily meal but a luxury treat for some special occasions.

With regard to lifestyle, we should distinguish preschoolers and school children because preschoolers' lifestyle is mostly determined by parents. For primary school children, unlike their American peers who spend much time snacking over television viewing (Gortmaker et al. 1996), Chinese primary school children simply do not have much spare time to do so, although a relationship between the prevalence of obesity and television watching is also observed among Chinese children (Yang et al. 2000, cited in Luo and Hu 2003). Urban children have too much homework to finish after school, have gym classes several times a week, and they do early morning exercise and between-class exercise regularly. Besides, many children walk or bike to school. For rural children, contextual, household and school characteristics all prevent them from living a sedentary lifestyle.

Thus, it does not seem to matter whether or not a child has sibling(s) and where they live – the dietary structure and lifestyle for the majority of Chinese children are not conducive to a high prevalence of overweight. This does not deny the fact that the dietary structure of the Chinese is changing, that the time children spend on watching TV is increasing, and that snack consumption among children is rapidly growing, particularly for those in the urban settings. All of these changes are underway, and these may account for the rising prevalence of overweight among children. Nevertheless, there may be a threshold at which these changes transform a healthy child into an overweight child, which has not yet been reached in China.

Two other factors may also contribute to the non-significant effect of policy and sibship composition on overweight risk. First, under the low fertility regime, each household has fewer children and each child becomes more precious to parents than before. This, coupled with food availability, suggests that only children and children with siblings may be treated similarly in terms of nutritional resources, leading to similar overweight risk of single children and children with siblings. Second, it is possible that children in strong policy communities and single children possess more modern health knowledge on overweight/obesity and hold modern body image. Large-scale campaigns have been launched in large cities since the late 1990s (*People's Daily* 2000), which are expected to promote parents and children's awareness of the negative effect of overweight/obesity. Thus, while children in strong policy communities and single children possibly live a more sedentary lifestyle and consume more high-fat food than others, their health knowledge helps prevent them from suffering the overweight risk.

This analysis also highlights the following findings. Two variables are consistently significant predictors of the overweight risk across samples and analyses: parental BMI and province. If a child has overweight parent(s), she/he is more likely to be overweight, consistent with previous studies in China (Luo and Hu 2003; Wang et al. 2002). Shandong children are many times more likely to be overweight than their peers in other provinces across all years.

It is not surprising that children in Shandong province have a high overweight risk. Overall, northern residents (those in Heilongjiang, Liaoning, Shandong and Henan in this analysis) are bigger in body build and weigh more than central (Hubei, Hunan and Jiangsu) and southern (Guangxi and Guizhou) residents. Shandong, as a coastal province, is far more developed (Meng and Wu 1998) than the rest of the provinces in the survey areas except for Jiangsu. However, it remains traditional in many ways, such as attitudes towards body image, dietary structure and eating habits. While Jiangsu is more advanced than Shandong, its development is limited in the southern part, which has a substantially different lifestyle, diet, and body ideology from Shandong, all of which prevent children from becoming overweight.

Additionally, there might be other mechanisms that account for the province-overweight connection. Since some factors that may explain the strong province effect on overweight risk (such cultural norms towards body image and eating habits) are not available or cannot be measured accurately in the CHNS, a qualitative approach may help collect relevant data to better understand the underlying forces for province to affect child overweight.

Limitations are present in this analysis. The first concerns the low follow-up rate in the longitudinal analysis. A substantial proportion of children present at baseline were lost to follow-up in 1997 and/or 2000, and the attrition analysis has found significant differences in characteristics at baseline between follow-ups and dropouts. This compromises the internal validity of this analysis. However, the dropout should not affect the cross-sectional analysis of the overweight risk in 2000 among children 7-12, which yields similar results to the longitudinal analysis with regard to the effect of the one-child policy and sibship composition on overweight.

The second issue pertains to the generalizability of this analysis. The study population is from nine non-randomly selected provinces. It is likely that contextual effects on overweight may be complementary in some situations but substitutive in others, limiting the inferential power of this analysis. However, the survey provinces consist of poor, rich and medium-income provinces, represent about half of China's total population, and considerably differ from one other in socioeconomic development, dietary structure and behavioral patterns. Thus, it remains possible that the results may be generalizable for residents of neighborhoods beyond these provinces.

Lastly, while individual and household-level factors are adjusted for, the presence of significant variation at the community-level could be attributable to the omission of other important individual or household-level covariates. No adjustments are made in this study for individual behaviors (e.g., food intake and physical activity) or household behaviors (e.g., feeding practice). However, I believe that their effect is additive, not interactive with the one-child policy and sibship composition. On the other hand, as the distinction between individual, household- and community-level factors is not always clear (for example, household background can be affected by neighborhood economic factors), it is also possible that we have underestimated the impact of neighborhood through over-adjusting for individual/household level socioeconomic status.

Despite these limitations, this study contributes to the current literature. It is one of the few studies that have examined the consequences of policy variations for children beyond family formation. Such variations are important because they shape local and family context, which, in turn, affect child outcomes. It takes advantage of the panel data of the CHNS by adopting both longitudinal and cross-sectional approaches, shedding insight on the time trend of overweight risk and also giving a snapshot of overweight risk at a given point in time. The panel analysis enables me to comment on the direction of causation between the one-child policy and the overweight risk, although such causation does not emerge in this study. This study also takes into account the hierarchical nature of the data by adopting multilevel modeling techniques. The joint investigation of social context and individual-level variables can provide a more complete understanding of the determinants of overweight and a basis for planning improvements in public health. Previous studies have shown some evidence of the impact of social context on physical health outcomes and behaviors, whereas only a few studies have investigated the impact of social context on overweight. This study provides evidence of an association between social context and overweight risk, independent of individual and household characteristics, and suggests that context is substantively important and statistically significant to the rising overweight epidemic in China. Neighborhood-based measures account for a substantial amount of variability in individual health outcomes.

In conclusion, this study finds little evidence that the one-child policy is associated with the rising incidence of child overweight risk in the transitional society. Instead, differentials in child overweight mostly result from other socioeconomic processes influenced by a number of factors and regional disparities. Because of these, overweight risk is modifiable and susceptible to policy intervention. Overweight develops over time and cannot be solved overnight; the best way to have a healthy weight is prevention. At a public health policy level, results from multilevel analyses imply that, first, improvements in health might be achieved at both the neighborhood and individual/household levels, although greater rewards might be gained from interventions targeting individuals and households. Second, prevention efforts should start at an early age because overweight among preschoolers is much higher than among primary school children. Third, attention should be paid to regional disparities, Shandong in particular. In doing so, it is important to take into account traditional attitudes toward the body. Different from poverty-driven malnutrition, overweight has long been regarded as a symbol of health, wealth and prestige. The one-child policy institutions can play a role, together with health institutions, in targeting overweight, just as they have successfully done in reducing child malnutrition.

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Table 1. Cross Tabulation (%) between the One-Child Policy Strength and Sibship Composition for Overweight Sample among Children Age 7-12 (N=1077)

	One-child policy (strong)	Girl-exception policy (moderate)	Two-child policy (weak)
Single child	44.420	29.220	18.720
1 sibling			
(by sibling gender)			
1 brother	24.950	28.720	28.370
1 sister	13.590	26.450	20.860
(by sibling order)			
1 older sibling	24.750	38.040	27.270
1 younger sibling	13.790	17.130	21.930
(by sibling density)			
1 sibling widely spaced (>36 months)	20.890	34.760	16.040
1 sibling closely spaced (<=36 months)	17.650	20.400	33.160
2+ sibling	17.040	15.620	32.090
Girls	46.650	45.090	43.850
N	493	397	187

Note: The source is the 1993 CHNS (for policy strength) and 2000 CHNS (for sibship composition). The sample is from Heilongjiang, Liaoning, Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou.

Table 2. Variable Construction and Definition for Overweight Sample

Variables	Definitions
Dependent Variable	
Overweight in 2000	1=the child is overweight in the 2000 survey; 0=otherwise
Time trend of overweight	1=the child is overweight in 1993, 1997 or 2000; 0=otherwise
Independent Variable	
Individual characteristics	
Child weight in 1993	A child's weight in 1993, ranging from 3.5kg to 48.5kg
Child height in 1993	A child's height in 1993, ranging from 43.5cm to 117cm
Sibling composition	
Single child	1=the child has no sibling; 0=otherwise
1 sibling[1]	1=the child has only 1 sibling; 0=otherwise
2+ sibling	1=the child has 2 or more siblings; 0=otherwise
The child is a girl	1=girls; 0=boys
Age of children (in years)	0-12
Household characteristics	
Mother's education	
<=primary school	1=mother has no education or primary education; 0=otherwise
Middle school	1=mother has a middle school education; 0=otherwise
Post-middle school	1=mother has a post-middle school education; 0=otherwise
Overweight parents	1=either mother or father or both overweight; 0=otherwise
Household wealth	Consumption goods, including TV etc., ranging from 0-12
Community characteristics	
One-child policy strength	
One-child policy (strong)	1=community implements the strict one-child policy; 0=otherwise
Girl-exception policy (moderate)	1=community implements the girl-exception policy; 0=otherwise
Two-child policy (weak)	1=community implements the two-child policy; 0=otherwise
Percent in agriculture	Percent of labor force engaging in agriculture, ranging from 0-100
Urban residence	1=living in city or suburban; 0=living in town or village
Province	
Heilongjiang[2]	1=Heilongjiang province; 0=otherwise
Liaoning	1=Liaoning province; 0=otherwise
Shandong	1=Shandong province; 0=otherwise
Henan	1=Henan province; 0=otherwise
Jiangsu	1=Jiangsu province; 0=otherwise
Hubei	1=Hubei province; 0=otherwise
Hunan	1=Hunan province; 0=otherwise
Guangxi	1=Guangxi Autonomous Region; 0=otherwise
Guizhou	1=Guizhou province; 0=otherwise
Survey year	
1993	1=The survey is conducted in 1993; 0=otherwise
1997	1=The survey is conducted in 1997; 1=otherwise
2000	1=The survey is conducted in 2000; 2=otherwise

Note 1: For children with only 1 sibling, I differentiate the sibling as the following categories:
(1) 1 brother or 1 sister; (2) 1 older sibling or 1 younger sibling;
(3) 1 widely spaced (>36 months) sibling or 1 closely spaced (<=36 months) sibling;

Note 2: Only available for cross-sectional analysis.

Table 3. Proportion/Means and Standard Deviations of Variables for Overweight Sample

	2000 cross-sectional analysis[1] (N=1077)		1993 baseline information of longitudinal analysis[2] (N=940)	
Individual characteristics	Mean/prop	SD	Mean/prop	SD
The child is overweight in 1993	n/a		0.238	
The child is overweight in 1997	n/a		0.100	
The child is overweight in 2000	0.107		0.110	
Child weight in 1993	n/a		14.851	(6.268)
Child height in 1993	n/a		94.067	(22.593)
Sibling composition				
Single child	0.344		0.347	
1 sibling[3]	0.470		0.444	
2+ sibling	0.190		0.219	
The child is a girl	0.456		0.455	
Age of children (in years)	9.970	(1.660)	3.208	(1.578)
Household characteristics				
Mother's education				
<=primary school	0.370		0.436	
Middle school	0.441		0.421	
Post-middle school	0.189		0.144	
Overweight parents	0.313		0.168	
Household wealth	5.370	(2.990)	4.733	(2.149)
Community characteristics				
One-child policy strength				
One-child policy (strong)	0.458		0.483	
Girl-exception policy (moderate)	0.369		0.324	
Two-child policy (weak)	0.174		0.193	
Percent in agriculture	51.530	(34.400)	52.087	(34.230)
Urban residence	0.250		0.196	
Province				
Heilongjiang	0.124		n/a	
Liaoning	0.096		0.094	
Shandong	0.062		0.082	
Henan	0.152		0.167	
Jiangsu	0.096		0.114	
Hubei	0.087		0.171	
Hunan	0.145		0.098	
Guangxi	0.122		0.142	
Guizhou	0.116		0.133	
Survey year				
1993	n/a		0.461	
1997	n/a		0.280	
2000	n/a		0.259	

Note 1. The sample includes children 7-12. Information is from the 2000 CHNS, except for the one-child policy strength, which is from the 1993 survey.

Note 2. Baseline characteristics (among children 0-5 in 1993) for the time trend analysis of overweight in 1993, 1997 and 2000.

Note 3. For those with only 1 sibling, in the cross-sectional (2000) sample, 26% have a brother, 20 a sister; (2) 30% have an older sibling, 16% a younger sibling; (3) 25% have a widely spaced sibling and 21% a closely spaced sibling. These figures slight

Table 4. Cross-Sectional Analysis of the Likelihood of Overweight for Children Age 7-12[1] (N=1077) (Multilevel Logistic Regression Results)

	Model 1			Model 2		
	Coef.		SE	Coef.		SE
Individual characteristics						
Sibship composition						
Single child (=ref)						
1 brother	-0.178		0.342	-0.367		0.343
1 sister	0.158		0.342	-0.319		0.352
2+ sibling	-0.390		0.429	-0.437		0.381
The child is a girl	-0.164		0.217	-0.133		0.206
Age of children (in years)	-0.104		0.072	-0.089		0.063
Household characteristics						
Mother's education						
<=primary school(=ref)						
Middle school	0.092		0.262	0.023		0.242
Post-middle school	0.137		0.372	0.179		0.318
Overweight parents	0.511	*	0.221	0.502	*	0.206
Household wealth	-0.026		0.048	-0.063		0.042
Community characteristics						
One-child policy strength						
One-child policy (strong) (=ref)						
Girl-exception policy (moderate)	-0.390		0.385	-0.263		0.262
Two-child policy (weak)	-0.366		0.527	-0.233		0.412
Percent in agriculture	-0.005		0.006	-0.003		0.004
Urban residence	0.547	^	0.303	0.083		0.322
Province (Shandong=ref)						
Heilongjiang	-1.457	**	0.556	-1.798	***	0.410
Liaoning	-1.453	**	0.558	-1.584	***	0.399
Henan	-1.236	*	0.532	-1.343	***	0.384
Jiangsu	-1.593	**	0.605	-1.837	***	0.452
Hubei	-1.825	**	0.591	-1.899	***	0.439
Hunan	-2.577	***	0.637	-2.946	***	0.519
Guangxi	-1.829	**	0.584	-2.297	***	0.445
Guizhou	-3.417	***	0.804	-3.818	***	0.699
Interactions between urban and						
(rural single children=ref)						
1 brother	-		-	0.849		0.592
1 sister	-		-	1.498	**	0.551
2+ sibling	-		-	0.592		0.897
Intercept	1.156		1.436	1.229		0.811
Random effect						
Between community variance	0.984	**	0.297	0.970		0.300
Intraclass correlation	0.230			0.230		
-2 Log Likelihood	700.025			690.533		

Note 1: The one-child policy information comes from the 1993 CHNS; the rest information comes from the 2000 CHNS. N of communities is 204, and N of observations is 1077.

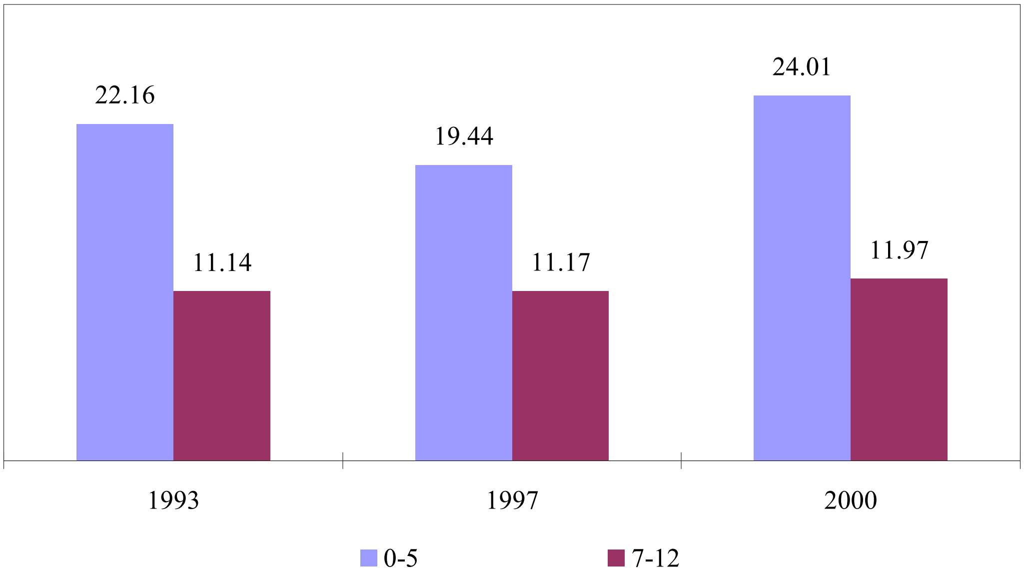
^p<0.10; * p<0.05; **p<0.01; ***p<0.001.

Table 5. Time Trend (Longitudinal) Analysis of the Overweight Risk Based on 940 Children Age 0-5 in 1993, and 566 and 529 Children during the Follow-ups in 1997 and 2000, Respectively (Multilevel Logistic Regression Results)

	Model 3			Model 4		
	Coef.		SE	Coef.		SE
Individual characteristics						
Child weight in 1993	0.294	***	0.025	0.297	***	0.025
Child height in 1993	-0.088	***	0.009	-0.089	**	0.010
Sibship composition						
Single child (=ref)						
1 brother	0.207		0.219	0.197		0.219
1 sister	0.056		0.232	0.027		0.232
2+ sibling	-0.086		0.249	-0.119		0.250
The child is a girl	0.114		0.169	0.103		0.170
Age of children (in years)	-0.186	*	0.080	-0.180	*	0.080
Household characteristics						
Mother's education						
<=primary school (=ref)						
Middle school	-0.394	*	0.174	-0.395	*	0.175
Post-middle school	-0.152		0.259	-0.121		0.260
Overweight parents	0.415	*	0.180	0.417	*	0.180
Household wealth	0.044		0.038	0.028		0.038
Community characteristics						
One-child policy strength						
One-child policy (strong) (=ref)						
Girl-exception policy (moderate)	-0.202		0.214	-0.251		0.214
Two-child policy (weak)	-0.169		0.239	-0.149		0.240
Percent in agriculture	0.007	*	0.003	0.006	*	0.003
Urban residence	0.043		0.245	-0.493		0.316
Province (Shandong=ref)						
Liaoning	-0.997	*	0.407	-1.027	*	0.409
Henan	-1.569	***	0.365	-1.592	***	0.365
Jiangsu	-1.400	***	0.389	-1.422	***	0.390
Hubei	-1.677	***	0.365	-1.693	***	0.364
Hunan	-1.004	**	0.376	-1.022	**	0.376
Guangxi	-1.747	***	0.393	-1.748	***	0.393
Guizhou	-1.691	***	0.443	-1.774	***	0.445
Survey Year 1993 (=ref)						
1997	-0.535		0.398	-0.828	*	0.414
2000	0.213		0.614	-0.016		0.630
Interactions						
Year*urban (1993, rural=ref)						
1997*urban				1.458	**	0.473
2000*urban				0.904	^	0.484
Intercept	3.867	***	0.849	4.175		0.861
Random effect						
Between community variance	0.450	**	0.142	0.443	**	0.141
Intraclass correlation	0.120			0.119		
-2 Log Likelihood	1493.073			1481.664		

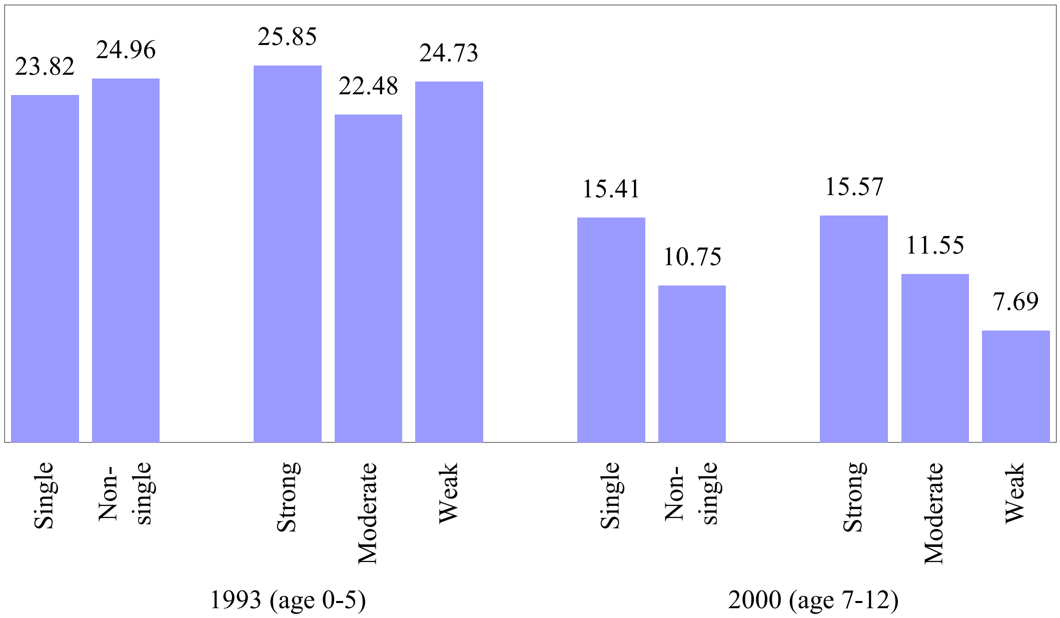
Note: The Source is the 1993, 1997 and 2000 CHNS. N of communities is 177. N of observations is 2034. ^p<0.10; * p<0.05; **p<0.01; ***p<0.001.

Figure 1. Trend of Overweight (%) by Age Cohort, CHNS 1990s



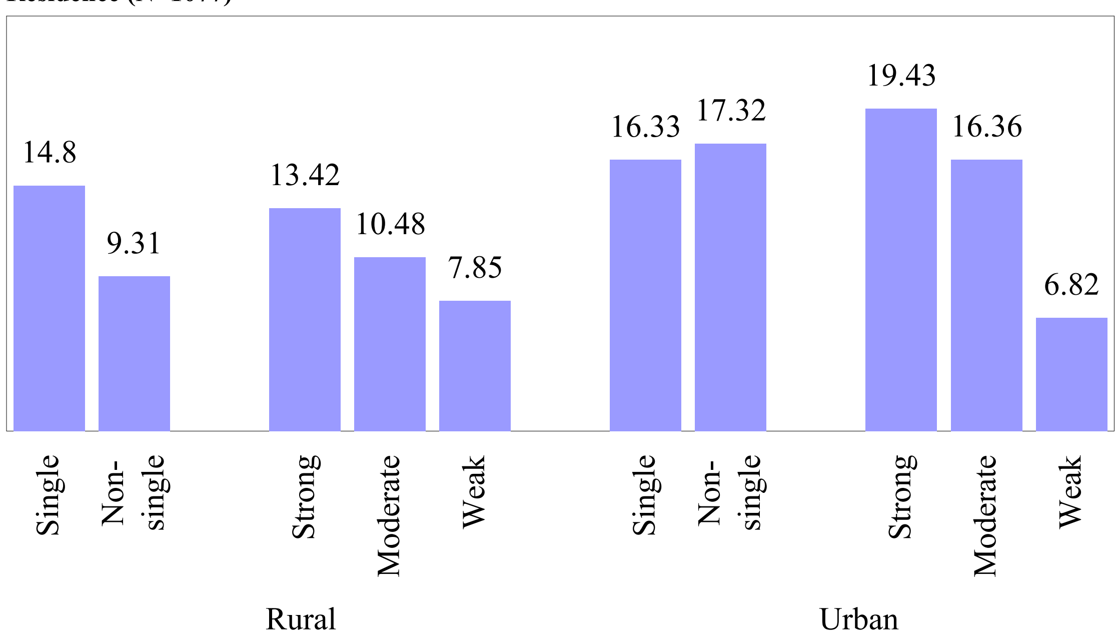
Note: The source is the 1993, 1997 and 2000 CHNS. The sample is from Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou provinces.

Figure 2. Prevalence of Overweight for Children 0-5 and 7-12 by Sibsize and Policy Strength (N of 1993 sample =940; N of 2000 sample=1077)



Note: The source is the 1993 and 2000 CHNS. The sample is from Heilongjiang (only for the 2000 sample), Liaoning, Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou provinces.

Figure 3. Prevalence of Overweight for Children 7-12 by Sibsize, Policy Strength and Urban Residence (N=1077)



Note: The source is the 1993 (only for policy) and 2000 CHNS. The sample is from Heilongjiang, Liaoning, Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou provinces.

Appendix 1. Unconditional Means Model Results for the Overweight Risk

Panel A.[1] Cross-sectional analysis of the overweight risk in 2000 among children age 7-12

Parameters	Coefficients	Standard error
Intercept	-1.93	0.13
Between community variance	1.34	0.31
Residual[a]	$\pi^2/3$	
Intra-community correlation	0.29	
N of individuals	1077	
N of communities	203	

Panel B.[2] Time trend analysis of overweight risk in 1993, 1997 and 2000 based on children age 0-5 at baseline (1993)

Parameters	Coefficients	Standard error
Intercept	-1.59	0.09
Between community variance	0.70	0.15
Intra-community correlation	0.18	
N of observations	2034	
N of communities	177	

Note 1. The one-child policy information comes from the 1993 CHNS; the rest information comes from the 2000 CHNS.

Note 2. It is a repeated measure analysis. Information comes from the 1993, 1997 and 2000 CHNS.

a. In binary model, residual is equal to $\pi^2/3$.