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**Peng Nie
Alfonso Sousa-Poza**

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Maternal Employment and Childhood Obesity in China: Evidence from the China Health and Nutrition Survey

forthcoming in Applied Economics

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Abstract

Using five waves from the China Health and Nutrition Survey (CHNS), we investigate the association between maternal employment and obesity in children aged 3–17 in both rural and urban China. Using BMI and waist circumference as measures for pediatric adiposity, we provide scant evidence for its relation to maternal employment. We also find no strong association between maternal employment and our measures for children's diet and physical activity. Our study also suggests that grandparenting could have beneficial effects on childhood obesity.

JEL Classification Codes: I12, J13, J22

Keywords: Maternal employment; Childhood obesity; China

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Maternal Employment and Childhood Obesity in China: Evidence from the China Health and Nutrition Survey

I. Introduction

The alarming rise in obesity rates among children and adolescents is affecting countries around the globe (Cawley, 2009; Sassi, 2010; Wang and Lobstein, 2006), with China being no exception. In fact, like economic growth and urbanization, the prevalence of overweight and obesity among Chinese children and adolescents is rapidly on the increase (Cui et al., 2010; Liang et al., 2012; Song et al., 2013; Yu et al., 2012; Zhang and Wang, 2012; Zhang et al., 2012). For example, the latest survey by the Chinese Center for Disease Control and Prevention's (CCDC) reports that in 2011, the number of overweight and obese children below the age of 18 years was 120 million (Li, 2012). Based on the International Obesity Task Force (IOTF) reference, the prevalence of general obesity and abdominal obesity in Chinese children aged 6-17 has increased dramatically from 1993 to 2009: general obesity increased from 6.1% to 13.1% and abdominal obesity from 4.9% to 11.7% (Liang et al, 2012). These levels of childhood obesity are expected to increase the prevalence of chronic diseases such as cardiovascular disease, strokes, type 2 diabetes, and a subset of cancers (Hill and Peters, 1998; Hill et al., 2003; Hossain et al., 2007), as well as certain social and mental health problems (OECD Obesity Update, 2012). In China, it is

estimated that approximately 1.7 million 7–18 year old children already have diabetes and 27.7 million are prediabetic (Yan et al., 2012).

One reason proposed for the increase – and one that has received much academic and popular attention – is the rise in maternal employment, whose relation to childhood obesity is the subject of a large body of literature (see, e.g., Anderson et al., 2003; Benson and Mokhtari, 2011; Cawley and Liu, 2012; Fertig et al., 2009; Herbst and Tekin, 2011). The rationale underlying this conjecture is that employed mothers spend less time at home, which could result in an increase in children’s unhealthy eating behaviors and sedentary activities. Nevertheless, virtually all studies testing this assumption are based on Western data, particularly U.S. data, which provide robust empirical evidence that maternal employment actually has a positive effect on childhood obesity (see, e.g., Anderson et al., 2003). The evidence for several European countries, however, is nowhere near as clearcut (see Greve, 2011; Gwozdz et al., 2013).

In this paper, we contribute to the research stream by analyzing the relation between maternal employment, childhood obesity, diet, and physical activity in China, a particularly interesting topic for three reasons: First, research outside the Western world is so limited that it is impossible to assess the extent to which the positive relation between maternal employment and childhood obesity can be generalized; especially, in light of the recent ambiguous evidence for Europe. Second, Chinese female employment rates are among the highest in Asia (Crabtree and Pugliese, 2012),¹ with a 72 percent employment rate among mothers aged 25–34 who have children under the age of 6 (Third Survey on

¹ More details are available at <http://www.gallup.com/poll/158501/china-outpaces-india-women-workforce.aspx>.

Chinese Women's Social Status, cited in Wang, 2011). If maternal employment *per se* affects child obesity, then arguably, this influence should be observable in China. Third, child care in China is to a large degree carried out by grandparents, which lessens the mother's dual burden of household chores and employment (Cooke, 2005). Yet the fact that nearly a quarter of the nation's children and almost a third of its rural children are growing up with grand- and great grandparents has received substantial negative press (e.g., *Los Angeles Times*, 2010; Luo, 2005) on the grounds that this "left behind" generation faces stark psychological and emotional challenges that could translate into obesity.

The purpose of this study, therefore, is to improve our understanding of the association between pediatric adiposity and female employment by using data from the China Health and Nutrition Survey (CHNS). To the best of our knowledge, this analysis is the first attempt to evaluate the association between maternal employment and childhood obesity using Chinese data². The choice of the CHNS dataset is particularly appropriate because the survey includes both useful anthropometric measures of obesity and rich information on children's diets and physical activity enables direct analysis of these two main drivers of obesity. Based on our results, we conclude overall that maternal employment is not significantly related to obesity, diet, and physical activity in Chinese children aged 3–17 years.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature, Section 3 describes the data and methods, Section 4 presents

2 Liu et al. (2013) investigate changes of China's urban-rural child (below 18 years old) health and nutritional status over 1989-2006 and find that there is no association of maternal employment status with z scores of child height-for-age and weight-for-age, and also anthropometric outcomes of being stunted and being underweight.

the results, Section 5 reports some robustness tests and Section 6 summarizes the conclusions.

II. Prior research

Most of the growing body of literature on the maternal employment-child obesity relation originates in the United States (Anderson et al., 2003; Benson and Mokhtari, 2011; Cawley and Liu, 2012; Fertig et al., 2009; Herbst and Tekin, 2011; Liu et al., 2009; Miller, 2011; Miller and Han, 2008; Morrissey et al., 2011; Ruhm, 2008). Nevertheless, research on this topic has also been conducted in Australia (Bishop, 2011; Brown et al., 2010; Champion et al., 2012; Zhu, 2007), Canada (Baker and Milligan, 2008; Chia, 2008; Phipps et al., 2006), Japan (Gaina et al., 2009), the UK (Champion et al., 2012; Hawkins et al., 2007; Scholder, 2008), Denmark (Greve, 2011), Spain (Garcia et al., 2006), and in eight other European countries (Gwozdz et al., 2013).³ For the purposes of this study, two insights from this research stream are particularly important.

First, studies for the U.S. provide strong evidence of a positive effect of maternal employment on childhood obesity, although the magnitude of this effect varies substantially. Although this positive effect tends to be supported by studies for the UK (Champion et al., 2012; Hawkins et al., 2007; Scholder, 2008), European studies are far less conclusive, giving evidence of no effects (Gwozdz et al., 2013) or even negative effects (Greve, 2011). The only non-Western study that we are aware of is Gaina et al.'s (2009) investigation of the relation between maternal

³ See Greve (2008), Gwozdz et al. (2013), and Scholder (2008) for useful literature reviews of these extant studies.

employment status and nutritional patterns in 12 to 13 year-old Japanese children, which finds a positive effect of the former on the latter.

Second, very few studies look directly at how maternal employment could affect the two main transmitters of obesity: diet and physical activity. As regards the first, a few studies do examine how maternal employment affects meal patterns (Gaina et al., 2009; Neumark-Sztainer et al., 2003; Siega-Riz et al., 1998), expenditures on purchased meals (Horton and Campbell, 1991; McCracken and Brandt, 1987), and time spent cooking (Cawley and Liu, 2012). Only Gwozdz et al. (2013), however, analyze how maternal employment affects caloric intake, and they identify no significant differences between the intake of 2–9 year old children of employed and nonemployed mothers in 8 European countries. In terms of physical activity, although a number of studies document an association between maternal employment and an increase in children's sedentary activities such as watching TV (e.g., Fertig et al., 2009; Ziol-Guest et al., 2013), other studies observe no such relation (Bonke and Greve, 2012; Gwozdz et al., 2013). Moreover, we are unaware of any studies that analyze the effect of maternal employment on children's diet and physical activity in China.

III. Data and Methods

Study Design and Population

The data used in the present study are taken from the China Health and Nutrition Survey (CHNS), which has been conducted in 8 waves since 1989 (1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009). The survey sample was drawn from 9

provinces (Liaoning, Heilongjiang⁴, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou) with different social, economic, and health situations. The multistage random cluster sampling method (Popkin et al., 2011), which is based on income level (high, mediate, and low) and weighted sampling, consists of the following steps. After randomly selecting four counties and two cities within each province, the CHNS team identifies villages and towns in each county, and urban and suburban regions in each city. From each of these communities, 20 households are selected (Popkin et al., 2011).⁵

In this present study, the selected sample comprises 2,618 children aged 3 to 17 years, with 155, 318, 643, 661, and 841, respectively, from the 1997, 2000, 2004, 2006, and 2009 survey waves. Because our targeted indicators are selected from different survey items for which some information may be missing, we perform our analyses on different sample sizes. In particular, we analyze three age groups separately: 3–17 year olds, 3–5 year olds, and 6–17 year olds, the last chosen to reflect the fact that Chinese children generally enroll in primary education at age 6. The estimates for the effect of maternal employment on child diet are for children aged 3–17 years based on data from 1997, 2000, 2004, 2006, and 2009. However, because of data availability constraints, the estimates for the effect of maternal employment on child physical activity are restricted to children aged 5–17 years in the data from 2004, 2006, and 2009⁶.

⁴ Heilongjiang province was introduced as the ninth province in 1997.

⁵ See Liu (2008) and Popkin et al. (2011) for more detailed information about the CHNS.

⁶ In the CHNS, information about physical activities of children (especially time spent on these activities), is available from 2004 onwards. With regards to time devoted to physical activities for children aged below 5 years, the data are mostly unavailable due primarily to large missing values.

Study Variables

Anthropometric measures

We use two measures for obesity: BMI for general obesity and waist circumference for central obesity. The first is calculated as weight in kilograms divided by squared height in meters, with weight measured with lightweight clothing on a calibrated beam scale and expressed in kilograms to the nearest 0.1 kg. Height is measured without shoes on a portable stadiometer and expressed in centimeters to the nearest 0.1 cm (Xi et al., 2012). Although several growth references are available, including those from the Center for Disease Control (CDC) 2000, WHO 2006 and 2007, and the International Obesity Task Force (IOTF) (developed by Cole et al., 2000), the IOTF growth charts, based not only on the U.S., Great Britain, Netherlands, and Brazil but also on Hong Kong and Singapore, are probably the most appropriate for evaluating Chinese overweight and obesity (see also Ma et al., 2011; Monasta et al., 2010). We therefore use the BMI z -scores from the IOTF growth charts.

BMI, however, although the most common measure of adiposity in studies on maternal employment and childhood obesity, is so general a measure that it may be incapable of accurately reflecting obesity changes, especially as it gives no indication of fat distribution (Demerath et al., 2006; McCarthy et al., 2001; Rolland-Cachera, 2011). We therefore also use waist circumference⁷ measured horizontally with an inelastic tape at the midpoint between the lowest rib and the iliac crest (Liang et al., 2012), and expressed in centimeters to the nearest 0.1 cm. Weight, height, and waist circumference were all measured by trained health

⁷ It is worth noting that among 6–17 year old Chinese, the increase in waist circumference is much larger than that in BMI (Liang et al., 2012).

workers based on WHO's (1995) standard protocol. The z -scores for waist circumference are derived from the British 1990 growth reference (see Cole et al., 1998).

Maternal employment

Our independent variables are selected based on a traditional production function in which child health outcomes rely on parental nonmarket time and other investments (Ruhm, 2004, 2008). We use a dummy variable to capture maternal employment status, measured by the question "Are you presently working?" If a woman is currently employed, the employment variable equals 1 and 0 otherwise, so nonemployed women are the reference group.

As a robustness check, we also employ maternal working hours (MWH), measured by "how many hours did you work during the past week?". In order to capture potential nonlinearities in maternal working hours we implement dummy variables. Specifically, maternal working hours are divided into 7 groups: 0 (as the reference group), $0 < \text{MWH} < 20$, $20 \leq \text{MWH} < 30$, $30 \leq \text{MWH} < 40$, $40 \leq \text{MWH} < 50$, $50 \leq \text{MWH} < 60$ and $\text{MWH} \geq 60$.

We also include three sets of control variables: child, family, and socioeconomic characteristics. Our specification is thus similar to that of Gwozdz et al. (2013).

Child characteristics

The set of child characteristics includes four variables: age, gender, birth order, and numbers of siblings, two of which, gender and birth order, are dummy variables. The gender dummy equals 1 if the child is a boy, 0 otherwise, and the birth order dummy equals 1 if the child's birth order is first, 0 otherwise.

Family characteristics

With regard to family characteristics, we include six variables: parental age (mother/father), parental BMI (mother/father), household size, and father's employment status, which is a dummy equal to 1 if the father is presently employed, 0 otherwise.

Socioeconomic characteristics

A third set of control variables measures the socioeconomic characteristics of household net income and parental education level. The latter is represented by years of schooling. Household income data were collected by trained interviewers based on a household questionnaire.

Our econometric model is as follows:

$$W = \beta_0 + M\beta_1 + C\beta_2 + F\beta_3 + S\beta_4 + T\beta_5 + P\beta_6 + \mu \quad (1)$$

where W is a matrix of child obesity measures, M is a matrix of mother employment status, C is a matrix of child variables, F is a matrix of family variables, and S is a matrix of socioeconomic variables. T is a matrix of survey year dummies with 1997 as the reference year, P is a matrix of provincial dummies (Liaoning province as the reference), μ is a matrix of disturbance error terms, and β_1 is the key coefficient of interest. For equation (1), we estimate both OLS and quantile regressions.

It is important to stress, however, that establishing a causal relation between maternal employment and child weight is impossible in our cross-sectional setting, especially given that maternal employment status might be endogenous. In this case, determining the magnitude and direction of a possible bias a priori is

not only difficult but purely speculative. In our analysis, therefore, we try to account for endogeneity by using a very rich set of child and family characteristics.⁸

Nonetheless, it is still impossible to test whether or not our variable set eliminates all unobserved heterogeneity. It is worth noting, however, that all the IV-based research of which we are aware (e.g., Greve, 2011) shows maternal employment status to be clearly exogenous, which may lend some support for the assumption that the endogeneity of maternal employment may not be a major problem in such models.

Diet

Because obesity is generally a consequence of excess caloric intake combined with insufficient physical activity, this study measures children's dietary patterns using two variables: meals at home and caloric intake (kcal). The first is calculated as the ratio of meals taken at home (over 3 days) to total meal times; the second as the average daily caloric intake (averaged over 3 days). With the exception of children under the age of 12 (whose individual dietary intake is reported by the mother or caregiver), all respondents were asked directly about all food consumed inside and outside the home. Also recorded were food items, meal types, and places of food consumption on the previous day (Cui and Dibley, 2012).

⁸ We also conducted our analysis with the use of the two-stage estimation procedure proposed by Lewbel (2012). In our case, we adopt child birth order and year dummies as instrumental candidates and our results show that there is no association between maternal employment and child adiposity. The estimate results of Lewbel's technique are not reported here but available from the authors upon request.

Physical activity

A child's physical activity is measured by calculating the time a child spends weekly on physical exercise before or after school (measured in minutes per week). This physical exercise consists of 4 major types: gymnastics, track and swimming, ball games (e.g., basketball, volleyball, soccer, table tennis), and other sports (e.g., martial arts) (Dearth-Wesley et al., 2012). We also compute sedentary activity based on the total time spent watching TV, doing homework, and reading and writing (measured in minutes per week).

Our econometric model is thus

$$P = \theta_0 + M\theta_1 + C\theta_2 + F\theta_3 + S\theta_4 + T\theta_5 + P\theta_6 + \mu \quad (2)$$

where P is a matrix of diet and physical activity of children, M is a matrix of mother's employment status, C is a matrix of child variables, and F is a matrix of family characteristics. S is a matrix of socioeconomic variables. T is a matrix of survey year dummies with 1997 as the reference year, P is a matrix of provincial dummies (Liaoning province as the reference), μ is a matrix of disturbance error terms, and θ_1 is the key coefficient of interest. For equation (2), we estimate OLS regressions.

Statistical Analysis

Our econometric models examine the association between childhood obesity and maternal employment using OLS regressions, which reveal substantial differences between urban and rural areas in China, especially with regards to economic development. Hence, as a robustness test, we also undertake an urban-

rural comparison using quantile regressions to investigate the different impacts of maternal employment on pediatric adiposity at different points along the obesity measure distribution (see, e.g., Herbst and Tekin, 2011). We report the descriptive statistics in Appendix Table A1. The prevalence of employed mothers in our analysis is 78.8% in comparison to 21.2% unemployed mothers. Additionally, in urban area, the prevalence of employed mothers is 71.8%, which is approximately 10% lower than that of rural area⁹ (not reported in Table A1).

IV. Results

Maternal employment and childhood obesity

The regressions¹⁰ examining the association between maternal employment and child obesity among the different age groups (see Table 1) indicate no significant relation between these two variables, a finding contrary to those in most previous studies but in line with Gwozdz et al. (2013) and Greve (2011). It is also worth noting that nearly all coefficients for maternal employment are negative, albeit not significantly so. This insignificant association of maternal employment with childhood obesity is further highlighted by evidence from the urban-rural comparison (see Table 1).

⁹ In our dataset, 533 mothers are currently employed but 209 mothers are unemployed in urban area, while in rural area, the number of employed and unemployed mothers are 1531 and 345, respectively.

¹⁰ Results also indicate that parental education is positively associated with child adiposity, which is echoed by some previous studies (Johnson et al., 2006; Lakshman et al., 2013).

Table 1 OLS estimates of maternal employment on obesity measures

Variables	BMI z-score			Waist circumference z-score		
	3–17	6–17	3–5	3–17	6–17	3–5
All	-0.087 (0.065)	-0.056 (0.067)	-0.145 (0.163)	-0.039 (0.101)	-0.092 (0.105)	0.317 (0.309)
Observations	2614	1863	751	2163	1740	423
Adj. R^2	0.090	0.135	0.023	0.045	0.049	0.015
Urban	-0.086 (0.115)	-0.008 (0.120)	-0.319 (0.322)	0.021 (0.155)	0.059 (0.162)	-0.166 (0.455)
Observations	738	537	201	603	490	113
Adj. R^2	0.104	0.153	0.019	0.040	0.053	0.000
Rural	-0.078 (0.079)	-0.082 (0.084)	-0.069 (0.186)	-0.074 (0.130)	-0.178 (0.138)	0.594 (0.400)
Observations	1876	1326	550	1560	1250	310
Adj. R^2	0.087	0.125	0.033	0.049	0.057	0.039

Source: China Health and Nutrition Survey, authors' calculations.

Note: Dependent variables are BMI z-score and waist circumference z-score. Controls include child, family and socioeconomic characteristics, dummies of year (1997 as the reference year), province (Liaoning as the reference) and urban (rural as the reference). Urban-rural split analysis is without urban dummy. 3-17 means $3 \leq \text{child age} \leq 17$, 6-17 means $6 \leq \text{child age} \leq 17$, and 3-5 means $3 \leq \text{child age} < 6$. Robust standard errors are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In the results for the quantile regressions, maternal employment is only significantly *negatively* linked to BMI at the 50% and 95% cut-offs: that is, at the upper end of the BMI distribution (see Table 2). Taken at face value, this result seems to support the negative influence of maternal employment on BMI indicated in Greve (2011). Interestingly, however, using waist circumference as another variable for adiposity produces no significant results, which echoes Burkhauser and Cawley's (2008) conclusion that different measures of fatness can give rise to quite different results.

Table 2 Quantile regression of maternal employment on obesity measures for 3-17 children

Variables	(10%)	(25%)	(50%)	(75%)	(85%)	(95%)
BMI z-score	-0.010 (0.106)	-0.098 (0.082)	-0.142** (0.063)	-0.109 (0.087)	-0.098 (0.088)	-0.269* (0.151)
Observations	2614	2614	2614	2614	2614	2614
Pseudo R ²	0.053	0.046	0.065	0.083	0.090	0.086
Waist circumference z-score	0.060 (0.200)	0.032 (0.118)	-0.100 (0.088)	-0.124 (0.084)	-0.079 (0.116)	0.022 (0.127)
Observations	2163	2163	2163	2163	2163	2163
Pseudo R ²	0.051	0.034	0.034	0.036	0.051	0.071

Source: China Health and Nutrition Survey, authors' calculations.

Note: Dependent variables are BMI z-score and waist circumference z-score. Controls include child, family and socioeconomic characteristics, dummies of year (1997 as the reference year), province (Liaoning as the reference) and urban (rural as the reference). Bootstrapped standard errors are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Overall, our analysis provides little evidence that children's current obesity is positively associated with current maternal employment status. However, as we cannot rule out the possibility that current maternal employment affects future obesity levels, we also analyze the effect of maternal employment on the direct drivers of obesity. If this effect is present, current maternal employment should have an immediate (i.e., not lagged) effect on children's diets and physical activity¹¹.

Maternal employment, diet, and physical activity

As is evident from the estimates in Table 3, maternal working status is not significantly associated with caloric intake, meals at home, physical exercises, and/or sedentary activities. Nor does the urban-rural comparison reveal

¹¹ If child weight is assumed to be a short-term outcome, child height might be a better proxy for long-term effects. Maternal employment may have a large impact on child height through increasing household income and improving child nutritional status. However, in our case, the correlation between maternal employment (including employment participation or working hours) and child height is negligibly small but negative.

significant results other than for meals at home in urban areas, which is significant at the 5% level.

Table 3 OLS estimates of maternal employment on diet and physical activity

Variables	Diet (ages 3–17)		Physical activity (ages 5–17)	
	Calorie	Meals	PE	SA
All	-0.015 (0.018)	0.035 (0.040)	0.079 (0.080)	-0.018 (0.034)
Observations	2614	1768	563	941
<i>Adj. R</i> ²	0.273	0.159	0.008	0.048
Urban	-0.021 (0.033)	0.188** (0.083)	0.099 (0.112)	-0.019 (0.055)
Observations	738	494	217	321
<i>Adj. R</i> ²	0.197	0.200	0.046	0.107
Rural	-0.027 (0.021)	0.008 (0.040)	0.038 (0.120)	-0.025 (0.044)
Observations	1876	1274	346	620
<i>Adj. R</i> ²	0.303	0.088	0.000	0.071

Source: China Health and Nutrition Survey, authors' calculations.

Note: The sample size of diet estimates is restricted to 1997, 2000, 2004, 2006 and 2009 (dependent variables are translog calorie intake and meals at home). And the sample size for estimates of physical activity and sedentary activities is restricted to 2004, 2006 and 2009 (dependent variables are translog physical exercise and sedentary activity). Controls include child, family and socioeconomic characteristics, dummies of year (1997 as the reference year), province (Liaoning as the reference) and urban (rural as the reference). Urban-rural split analysis is without urban dummy. PE means physical exercise. SA means sedentary activities. Robust standard errors are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

V. Robustness checks

Do maternal working hours really matter?

Our analysis above focused on maternal working status as the CHNS has a large share of missing values with regards to the working time of the mother (more than 50% of observations in our sample of mothers). Nevertheless, as the length of the working day may be more informative than the employment status (see also Scholder, 2008), we analyze the working time information for a sample for which information is available. In order to explore nonlinearity in working hours, we include dummy variables of maternal working hours into our analysis. It is

evident that, although the impact of maternal working hours on the z-score of BMI might be nonlinear, the estimates are not significant (see Table A2 in the Appendix)¹². These results thus do not either provide evidence of significant nonlinear effects of maternal working hours on child fatness.

Does grand-parenting really matter?

In China, the involvement of grandparents in the upbringing of their grandchildren is a topic of much public debate (see also Chen et al., 2011). Considering the important role of grand-parenting in China and its potential substitution of maternal child care when mothers are employed, we investigate how childcare of 3-6 year-old child by grandmothers associates with child adiposity among employed mothers. We focus on children aged 3-6 year as information on time input of childcare is only available for children in this age group. Furthermore, the demand for external childcare like grand-parenting is most probably much larger for these younger children. Considering the possible nonlinearities in grandmother childcare hours (GCH), we also use dummy variables of weekly childcare hours (nochildcare as the reference group, $0 < GCH < 6$, $6 \leq GCH < 20$ and $GCH \geq 20$). Results indicate that grandmother's childcare hours are generally negatively associated with z-scores of child BMI, but the estimates are statistically insignificant (see Table A3). As our estimation is based on a relatively small sample size (observations=169), power is obviously limited. The results may suggest, however, that such informal childcare by grandmothers might have beneficial effects and could be an effective

¹² Alternatively, we also checked the nonlinearity nexus between maternal working hours and childhood obesity by using maternal working hours and its squared as well as cubic terms. The conclusions are the same.

counterbalance against the negative effects of childhood obesity arising from maternal employment.

VI. Conclusions

The present study is the first to investigate the association between maternal employment and child adiposity in China while taking into account child, family, and socioeconomic characteristics. The analysis is based on a large 9-province survey, the China Health and Nutrition Survey (CHNS), which has been successfully administered for several waves and is subject to strict quality control strategies (Tudor-Locke et al., 2003). Although the detailed data it provides on dietary patterns and child physical activity enable direct analysis of maternal employment's impact on diet and physical activities, even after distinguishing between rural and urban households, we find no relation between maternal employment and the objective measures of childhood obesity. Furthermore, maternal employment does not appear to be related to either diet or children's physical activity.

Some limitations obviously deserve mention. First, our analysis is cross-sectional, thereby rendering a causal analysis impossible. Moreover, with regard to physical and sedentary activities (for those 6 years and older), we use self-reported data, which could produce biased reports of the time spent on physical activities and the intensity of participation (Hussey et al., 2007). In addition, we use Western growth charts, which might give rise to biases in evaluating central childhood obesity (as measured by waist circumference) in China. Finally, our analysis is sometimes hindered by relatively small sample sizes (and thus large

standard errors) – especially when taking a more differentiated look at subsamples.

Nevertheless, our results for China are well in line with recent empirical evidence for Europe (Greve, 2011; Gwozdz et al., 2013) and provide further evidence that maternal employment may not be detrimental to child obesity. In fact, our results show that, if anything, maternal employment may lower levels of childhood obesity, a finding tentatively explainable by the fact that, in China, the main resource for informal child care is grandparents, who are likely to provide a high quality of care.

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Appendix

Table A1 Descriptive statistics

Variables	Obs	Mean	SD	Obs	Mean	SD	T-test
	Employed mothers			Non-employed mothers			MD
<i>Obesity</i>							
BMI z-score	2064	-0.119	1.172	554	-0.044	1.267	0.163***
WC z-score	1721	-0.312	1.779	445	-0.259	1.879	0.053
<i>Diet</i>							
Meals at home	1431	2.703	0.588	341	2.664	0.644	-0.039
Caloric intake	2064	1526.859	622.06	554	1570.597	622.21	43.738
<i>Physical activity</i>							
Physical exercise	443	57.038	46.034	132	59.371	61.553	2.333
Sedentary activity	724	489.365	215.708	229	501.41	181.722	12.046
<i>Child characteristics</i>							
Age: child	2064	8.621	3.44	554	9	3.582	0.379**
Gender: child	2064	0.56	0.496	554	0.536	0.499	-0.024
Birth order	2064	0.853	0.354	554	0.892	0.311	0.039**
Number of siblings	2064	0.328	0.581	554	0.224	0.442	-0.104***
<i>Family characteristics</i>							
Age: mother	2064	34.982	5.225	554	35.891	6.585	0.909***
Age: father	2060	36.312	5.535	554	37.935	7.195	1.622***
Job status: father	2064	0.959	0.199	554	0.699	0.459	-0.260***
BMI: mother	2064	22.538	3.098	554	22.787	3.219	0.248*
BMI: father	2064	22.931	3.11	554	23.387	3.1	0.456***
Household size	2064	4.391	1.348	554	4.363	1.277	-0.028
<i>Socioeconomic characteristics</i>							
Household income	2064	9.672	1.016	554	9.505	1.162	-0.168***
Education: mother	2064	8.439	4.04	554	8.347	3.012	-0.092
Education: father	2064	9.318	3.669	554	9.323	3.330	0.005

Source: China Health and Nutrition Survey, authors' calculations.

Notes: The age group for BMI and waist circumference (WC) is 3 to 17 year-old Chinese children. The BMI z-score designates the z-score of body mass index (BMI) based on the IOTF growth references. The WC z-score designates the z-score of waist circumference based on the British 1990 growth reference. "Meals at home" refers to the ratio of meals taken at home (over 3 days) to total meal times. "caloric intake" means the 3-day average calorie intake, "physical exercise" means time spent on physical exercises per week before/after school, and "sedentary activity" means the total time spent watching TV, doing homework, and reading and writing (measured in minutes per week). Household income means translog household net income. Asterisks denote statistically significant difference between employed and non-employed. Obs means observations. SD means standard deviation. MD means mean difference.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2 OLS estimates of maternal working hours on obesity measures

Variables	BMI z-score		
	3-17	6-17	3-5
DWH=1 (0<MWH<20)	0.031 (0.170)	0.031 (0.177)	-0.284 (0.535)
DWH=2 (20≤MWH<30)	0.177 (0.170)	0.077 (0.178)	0.878 (0.544)
DWH=3 (30≤MWH<40)	0.160 (0.172)	0.103 (0.181)	0.515 (0.604)
DWH=4 (40≤MWH<50)	0.081 (0.156)	0.020 (0.165)	0.618 (0.479)
DWH=5 (50≤MWH<60)	0.115 (0.171)	0.012 (0.178)	0.801 (0.596)
DWH=6 (MWH≥60)	0.185 (0.179)	0.135 (0.184)	0.426 (0.659)
Observations	1211	1062	149
Adj. R ²	0.129	0.152	0.141

Source: China Health and Nutrition Survey, authors' calculations.

Notes: The dependent variable is BMI z-score. DWH indicates dummies of maternal working hours (non-working mothers as the reference group). MWH indicates maternal working hours. Controls include child, family and socioeconomic characteristics, dummies of year (1997 as the reference year), province (Liaoning as the reference) and urban (rural as the reference). 3-17 means 3≤child age≤17, 6-17 means 6≤child age≤17, and 3-5 means 3≤child age<6. Robust standard errors are in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$

Tables A3 OLS estimate of grandmother childcare hours on obesity measure

Variables	BMI z-score (3-6 year olds)
Dummy of grandmother childcare hours (0<GCH<6)	-0.242 (0.314)
Dummy of grandmother childcare hours (6≤GCH<20)	-0.248 (0.312)
Dummy of grandmother childcare hours (GCH≥20)	-0.331 (0.324)
N	169
R ²	0.079

Source: China Health and Nutrition Survey, authors' calculations.

Notes: The dependent variable is BMI z-score. GCH indicates grandmother childcare hours (no grandmother childcare as the reference group). Controls include child, family and socioeconomic characteristics, dummies of year (1997 as the reference year), province (Liaoning as the reference) and urban (rural as the reference). Standard errors are in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$

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