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Are Children with Siblings Really More Vulnerable Than Only Children in Health, Cognition and Non-cognitive Outcomes? Evidence from a Multi-province Dataset in China

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Abstract

The general goal of the present study is to analyze whether children with siblings lag behind their only-child counterparts in terms of health and nutrition, cognition and educational performance, and non-cognitive outcomes. We draw on a dataset containing 25 871 observations constructed from three school-level surveys spanning four provinces in China. The analysis compares children with siblings and only children aged 9 to 14 years old in terms of eight different health, cognitive and non-cognitive indicators. We find that with the exception of the anemia rate, health outcomes of children with siblings are statistically indistinguishable from those of only children. In terms of cognition, children with siblings performed better than only children. Moreover, outcomes of children with siblings are statistically indistinguishable from those of only children in terms of the non-cognitive outcomes provided by measures of anxiety. According to our results, the same general findings are true regardless of whether the difference between children with and without siblings is disaggregated by gender.

Key words: China, cognition, education, health status, nutrition, only children
JEL codes: I10, I12, I20

I. Introduction

In China, children with siblings make up only a relatively small share of the total

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number of children. According to China's census data, the number of children with siblings born in 2013 accounted for only around 36 percent of all children born that year (National Bureau of Statistics, 2014). Geographically, children with siblings are concentrated in relatively poor regions of western China. This is due to the fact that in the recent past in China's cities almost all parents only had one child. However, in western areas of the country, such as in Ningxia, Qinghai and Shaanxi, children with siblings comprise 45, 46 and 43 percent of the total number of children born in the province in 2010, respectively (National Bureau of Statistics, 2012)

Generally, it is believed that children with siblings historically have suffered in terms of health, nutrition and education, especially relative to their only children counterparts in poor regions of western China (Chen, 1985; Taubman and Behrman, 1986; Feng, 1992; Huang and Wen, 2008). Therefore, there are still concerns about the status of this potentially vulnerable group in China today. For this reason, the plight of children with siblings in China has drawn attention from researchers in many different fields. For example, empirical evidence has shown that children with siblings often have worse health outcomes than only children. A study that used pooled cross-sectional data on 5363 rural children from the China Health and Nutrition Survey (CHNS) in 1991–2009 found that children with siblings exhibited worse health outcomes than their only-child peers on average (Ren *et al*., 2014). For example, the average height-for-age z-scores of boys and girls under 10 years of age in one-child households (–0.71 for male only children; –0.71 for female only children) were higher than the average height-for-age z-scores of children in the same age cohort in households with multiple children (–1.32 for male children with siblings; –1.38 for female children with siblings). Likewise, the weight-for-age z-scores of only children under 10 years of age (–0.15 for male only children; –0.20 for female only children) are significantly higher than those of children in the same age categories than in households with multiple siblings (–0.67 for male children with siblings; –0.78 for female children with siblings). Another study has found that the rates of intestinal worm infection among only children (9.30 percent) is significantly lower than the rates of infection of children with siblings (27.30 percent) in the study area in rural Henan Province ($p < 0.01$, Jian, 1996).

In addition to negative anthropomorphic and health outcomes, similar types of findings occur between only children and children with siblings in terms of nutritional outcomes. Using a sample restricted to children under the age of 12 from the China Health and Nutritional Survey (CHNS) 1991–2000, one study found that only-child status was one of the most important predictors of nutritional status (Bredenkamp, 2002). Research conducted in Henan Province has also shown that the prevalence of anemia among only children aged 7–12 (17.28 percent) is lower than that of children with siblings (24.81 percent) of the same age range ($p < 0.01$, Jian, 1996).

In addition to the evidence presented on health disparities between children with siblings and only children, studies comparing these two groups have also found gaps in cognitive outcomes. For example, when researchers used two cognitive scales (the Wechsler Preschool and Primary School Childs Scale [WPPSI] and the Wechsler Intelligence Scale for Children [WISC-III]) to assess 204 pairs of only children and children with siblings in kindergarten, primary school, and middle school in Hefei City, Anhui Province, they found that the cognition of only children was higher than that of children with siblings (Zhan and Tang, 2002). Other studies have also revealed an inverse association between the number of siblings a child has with other educational outcomes, such as grades and standardized test scores (Zajonc and Markus, 1975; Blake, 1981; Steelman and Mercy, 1983; Blake, 1985; Steelman, 1985; Blake, 1989; Alwin, 1991; Mercy and Steelman, 1993).

While small in scope, the literature has also shown that children with siblings display poorer non-cognitive outcomes as compared to their only-child peers. For example, using two scales (Revised Children's Manifest Anxiety Scale [RCMAS] and the Fear Survey Schedule for Children-Revised [FSSC-R]), a study of children 7 to 17 years old in Tianjin demonstrated that children with siblings are more likely to display symptoms of anxiety and fear than only children (Yang *et al*., 1995).

In light of previous findings, whether children with siblings still lag behind their only children counterparts is worth reexamining for several reasons. While previous studies generally show that children with siblings suffer along dimensions of health, cognitive and non-cognitive outcomes as compared to only children, previous studies are dated, and, therefore, may be unable to speak to the current situation in China. Evidence suggests that in recent years all sub-populations have begun to enjoy higher levels of health and cognition due to falling rates of poverty and rising levels of human capital, even in China's poor rural areas (Goh *et al*., 2009; Zhang, 2014; Gao *et al*., 2015; Rambotti, 2015). Much of the previous research has been limited in scope, either in terms of geographic area or lack of a credible comparison group. Additionally, without taking into consideration the heterogeneity of characteristics of both only children and children with siblings across China's vast geography, previous studies may not have adequately recognized the underlying factors that impact the health, cognition, and noncognitive outcomes of these children.

The goal of the present study is to describe the health and nutrition (henceforth, health) status, the cognitive and educational (henceforth, cognitive) performance, and the non-cognitive outcomes of children with siblings aged 9 to 14 years in rural areas of China and to compare their outcomes to those of their only children peers. To do this, we draw on a dataset containing 25 871 observations constructed from three school-level surveys covering four provinces, all of which were collected after 2009. Using these data, we are able to compare children with siblings to only children in terms of eight different health, cognitive and non-cognitive outcome variables.

II. Methods

1. Data

The data used for this study are aggregated from three different school-level surveys that the authors of this paper and their collaborators conducted in rural areas of four provinces in Western China (Ningxia, Qinghai, Shaanxi and Guizhou) between 2009 to 2013. The ages of the children in the sample ranged from 9 to 14 years old. Table 1 provides the provinces, years, sample sizes and primary outcomes for each survey included in our analysis.[1]

Table 1. Description of Surveys and Datasets

(1) Dataset number	(2) Province	(3) Year	(4) Sample size	(5) Age	(6) Primary outcome variables
1	Shaanxi	2008	6995	9–14	Hemoglobin (anemia rate); standardized math test score; mental health test
2	Ningxia, Qinghai	2009	14 658	11–13	Hemoglobin (anemia rate); standardized math test score; mental health test
3	Guizhou	2013	4218	9–14	WAZ; HAZ; STH; hemoglobin (anemia rate); working memory; processing speed; standardized math test score

Notes: HAZ, height-for-age z-scores; STH, soil-transmitted helminthes; WAZ, weight-for-age z-scores.

2. Sample Selection

The observations of the three surveys were all selected using random sampling strategies that were nearly uniform across the studies. First, we obtained a list of all the counties in each of the four provinces. Second, we randomly selected sample counties from those meeting our study criteria. Third, using official records, we created a list of all primary (and/or secondary) schools in the sample counties. Fourth, we randomly selected schools from the resulting sampling frame. Finally, within each of the randomly selected schools we randomly selected students (or classes of students) for inclusion in the studies. We solicited the number of siblings directly from students as a part of the survey. The sampling strategies are described

[1]Interested readers can refer to the Stanford University website for more information about the individual surveys (http:/reap.stanford.edu/docs/628).

in the papers from which the data sources come.[2]

3. Data Collection and Outcome Measures

The dataset formed from the individual surveys can be considered a pooled dataset with different waves of observations of students from rural schools. In total, the dataset includes information on 218 schools from 20 rural counties in the four study provinces.

During the baseline survey we collected data on the basic demographic information of students, including gender and age. Table 2 provides definitions for the key variables used in the paper.

Table 2. Variable Definitions of Main Outcomes that are Used in Study

(1) Variable number	(2) Variable	(3) Description of variables
1	Weight-for-age z-scores (WAZ)	WAZ were calculated using a SAS program for the 2000 Center for Disease Control growth chart for children aged 0–20 years.
2	Height-for-age z-scores (HAZ)	Physical indicators of height were used to construct HAZ using WHO AnthroPlus, a software application of the WHO Reference 2007 for children aged 5 to 19 years old that is used to monitor the growth of school-aged children and adolescents.
3	Anemia rate	Hb < 115 g/L , if age >=9 and <=11 (1 = yes, 0 = no); Hb < 120 g/L , if age >=12 and <=14 (1 = yes, 0 = no).
4	Soil transmitted helminthes (STH) infection	Child is infected with any of the three types of STH: Ascaris, hookworm, or Trichuris (1 = yes, 0 = no).
5	Working memory index (WMI)	Score on the working memory module of the Wechsler Intelligence Scale for Children (WISC-IV test).
6	Processing speed index (PSI)	Score on the processing speed module of the Wechsler Intelligence Scale for Children (WISC-IV test).
7	Standardized math test score	Math test score that is standardized by subtracting the mean and dividing by standard deviation within each wave of survey and each project.
8	Mental Health Test (MHT)	The purpose of the test was to measure the level of each student's anxiety. The test is scored out of 90 points, where a lower (higher) score corresponds to lower (higher) anxiety.

The primary outcomes examined in this study include eight measures of health, cognition and non-cognitive outcomes. To measure health outcomes, we examine data on weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), infection with soil-transmitted helminthes (STH) and anemia prevalence. We collected three measures of cognition: working memory, cognitive processing speed and scores from standardized tests of math. We collected one measure of non-cognitive outcomes: scores on a mental

[2]These papers have been published elsewhere and interested readers are encouraged to refer to those papers for more detail (Liu *et al*., 2010; Luo *et al*. 2011; Miller *et al*., 2011; Luo *et al*., 2012a, b; Wang *et al*., 2012; Chen *et al*., 2013; Loyalka *et al*., 2013; Kleiman-Weiner, 2013; Sylvia *et al*., 2013; Wong *et al*., 2013; Yi *et al*., 2013; Zhang *et al*., 2013; Zhan *et al*., 2014).

health test.

The height and weight of children were measured and recorded by trained nurses from local provincial-level hospitals. WAZ were calculated using a SAS program for the 2000 Center for Disease Control growth chart for children aged 0–20 years (World Health Organization, 2009). Physical indicators of height were used to construct HAZ using WHO AnthroPlus, a software application of the WHO Reference 2007 for children aged 5 to 19 years old that is used to monitor the growth of school-aged children and adolescents (US Center for Disease Control and Prevention, 2002). Data on STH infections were collected from 2004 school-aged children in May 2013 in Guizhou Province. Children were considered positive for STH infection if either one of their stool samples tested positive for one or more types of STH. Hemoglobin concentrations (Hb) were measured on-site using a Hemocue Hb 201+ finger prick system. In accordance with WHO guidelines, we use an Hb cutoff of 115 g/L for children aged 9 to 11 years and 120 g/L for those aged 12 to 14 years (World Health Organization, 2001).

Measures of cognition, working memory and processing speed were generated using the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV. See Weschler, 2008) The working memory index (WMI) was assessed through two core subtests: the Digit Span subtest and the Letter Number Sequencing subtest. The processing speed index (PSI) was assessed through two core subtests: the coding subtest and the symbol search subtest. Raw scores obtained from these subtests were converted to age-scaled index scores using tables of norms from the official WISC-IV administration and scoring manual for China.

In addition to the formal cognitive tests, students were given a standardized math test. The tests were created by experts from the Shaanxi Provincial Department of Education using grade-appropriate materials that were part of the regular student curriculum. Our enumeration team monitored the tests, carefully proctored them in order to minimize cheating and strictly enforced the time limits. Scores on the standardized test were normalized (with mean zero and standard deviation equal to one (see Mo *et al*., 2013).

To measure non-cognitive outcomes, we used a test of psychological well-being, called the Mental Health Test (MHT) to assess children's mental health. The test is a variation of the Children's Manifest Anxiety Scale (CMAS), which has been widely used in the USA and other developed countries for more than a decade as a screening and clinical tool. Professor Zhou Bucheng of East China Normal University developed the MHT scale used in the present study (Zhou, 1991). Researchers have used this test extensively across China to measure the mental health of grade school students in urban contexts. The purpose of the test was to measure the level of each student's anxiety. The test was scored out of 90 points, where a lower score corresponds to lower levels of anxiety. The test results can be broken down into eight subcategories, each of which represents a specific aspect of anxiety: school performance, social relationships, loneliness, self-punishment, sensitivity, physical symptoms, fear and impulsiveness. A score of greater than 8 on any subpart is considered clinically high and indicates a need for treatment. A total score of 65 or higher indicates high general risk for mental health problems and an urgent need for professional intervention (Wang *et al*., 2012; Zhang *et al*., 2013).

4. Statistical Approach

To investigate whether children with siblings differ from their only children counterparts in terms of health, cognition and non-cognitive outcomes, we conducted both descriptive and regression analyses. First, we compared the means in outcomes between only children and children with siblings by conducting *t*-tests. The *t*-test results are the same as those that would be estimated by using the following OLS regression model:

$$Y_{ij} = \alpha + \beta X_{ij} + \varepsilon_{ij}, \tag{1}$$

where the dependent variable Y_{ij} is the outcome variable that measures health, cognition and non-cognitive outcomes of student i in school j, and X_{ij} indicates whether student i is an only-child in school j (the variable equals 1 if the student is an only-child and it equals 0 if the student is a child with siblings). The coefficient β indicates the difference in health, cognition and non-cognitive outcomes between the children with siblings and only children.

5. Ethical Approval

All studies were approved by the Stanford University Institutional Review Board (IRB) and relevant Chinese authorities. The caregivers of all participants provided informed oral consent and the children themselves provided oral assent. The investigation was conducted after all consents and assents were obtained.

III. Results

Overall, health indicators for the full sample are poor (Table 3). The normalized WAZ and HAZ of the sample children are –0.67 and –0.97, respectively. The rate of anemia prevalence is 23.3 percent and the STH infection rate is 41.7 percent.

Table 3. Sample Sizes and Values of the Outcomes for the Average Child of Our Full Sample in Rural China

(1) Outcome number	(2) Outcomes	(3) Sample size	(4) Unit	(5) Value
1	WAZ	1445	Z-score	–0.67
2	HAZ	4201	Z-score	–0.97
3	Anemia rate	17 414	%	23.3
4	STH infection rate	2168	%	41.7
5	Working memory	4216	45–150 points	78.5
6	Process speed	4216	45–160 points	87.3
7	MHT: Overall	21 015	0–90 points	36.4
8	MHT: Learning anxiety	21 015	0–15 points	7.8

Source: Authors' data.

Notes: See Table 2 for complete definitions of all variables. In this table, we only include outcome measure of variables that have stand-alone significance. We do not include (for example) standardized test scores for math because these scores are only used to compare the relative performance of children from different subpopulations. HAZ, height-for-age z-scores; MHT, mental health test; STH, soil-transmitted helminthes; WAZ, weight-for-age z-scores.

Out of the full sample (Table 4, column 4), the children and their families have characteristics that are similar to many samples from rural areas of Western China. Of the total number of students in the sample (25 871), 2825 of them are only children. This means that approximately 11 percent of students are only children and 89 percent are children with siblings (see heading line of table). Boys make up 53.4 percent of the sample, and girls only 46.6 percent (row 2). From this gender distribution we can calculate a ratio of boys to girls that is approximately 115:100, which is around the average sex ratio of boys to girls in rural China (National Bureau of Statistics, 2014). This number, however, is way above a normal boy to girl sex ratio for a normal population (between 103 and 106). The average size household in our poor rural China sample is 5.2, and over 40 percent of fathers and 20 percent of mothers do not live at home and work as migrant workers in China's cities (rows 4 to 6).

Columns 5 to 7 of Table 4 show the comparisons of child and family characteristics of only children and children with siblings in rural China. Perhaps the biggest difference between the groups is the male–female ratio. Specifically, the sex ratio imbalance of boys to girls is much higher for the only children group. In total, 66.6 percent of only children are boys, which amounts to a sex ratio of nearly 200 to 100. The share of boys is lower in the case of children with siblings (51.7 percent), making the sex ratio (107:100) almost normal (between 103 and 106; National Bureau of Statistics, 2014).

Table 4. Comparisons of Child and Family Characteristics of Only Children and Children with Siblings in Rural China

(1) Variables number	(2) Variables	(3) Unit	(4) Full sample	(5) Only children (N = 2825)	(6) Children with siblings (N =23 046)	(7) Difference (5) –(6)	(8) *p*-value
Child characteristics							
1	Age	Years	10.5	10.2	10.6	–0.4	0.00
2	Boy	(%)	53.4	66.6	51.7	14.9	0.00
3	Grade		4.43	4.18	4.45	–0.2	0.00
Family characteristics							
4	Household size	Number of members	5.2	4.0	5.3	–1.3	0.00
5	Father is a migrant	(%)	40.4	43.1	40.1	3.0	0.00
6	Mother is a migrant	(%)	20.8	32.8	19.3	13.5	0.09
7	Father's age	Years	38.4	37.8	38.4	–0.6	0.00
8	Father's education	% that obtained primary education	47.3	57.9	46.1	11.8	0.00
9	Mother's age	Years	35.8	34.6	35.8	–1.2	0.00
10	Mother's education	% that obtained primary education	34.6	53.7	32.2	21.5	0.00
11	Household asset value (Family wealth)	0–1 scale	0.3	0.3	0.3	0.0	0.00

Additionally, differences between these two groups emerge in terms of parental migration and education levels (Table 4). More parents (both fathers and mothers) out-migrate in one-child families than in families with more than one child (rows 5 and 6, columns 5 and 6). Additionally, fathers are somewhat more educated in families with only children (row 8).

With the exception of anemia rates, there are no statistically significant differences between children with siblings and only children in measures of health or nutrition status (Table 5, rows 1 to 4). In particular, the analysis found that WAZ (p-value = 0.27), HAZ (p-value = 0.47) and STH infection rates (p-value = 0.76) are statistically identical between children with siblings and only children. However, the prevalence of anemia is statistically higher among only children (27.2 percent) than children with siblings (22.7 percent, p-value < 0.01). The raw difference is 4.51 percentage points.

The results also show that children with siblings perform at least as well as their only children counterparts in terms of cognition (Table 5, rows 5 to 8). Children with siblings score higher than only children in terms of working memory (p-value = 0.01) and process speed (p-value < 0.01). However, although children with siblings perform better on measures of cognition, there is no statistically significant difference between children with siblings and only children in terms of the standardized math tests scores (p-value = 0.60). Additionally, in the case of non-cognitive outcomes, children with siblings perform similarly (36.4) to only children (36.3; p-value = 0.92).

Table 5. Comparisons of Health, Cognitive and Non-cognitive Outcomes of Only children and Children with siblings in Rural China

(1) Outcome number	(2) Outcome	(3) Sample size	(4) Unit	(5) Only-children N = 2825	(6) Children with siblings N = 23 046	(7) Difference (5) –(6)	(8) *p*-value
1	WAZ	1445	Z-score	–0.61	–0.69	0.08	0.27
2	HAZ	4201	Z-score	–0.94	–0.98	0.03	0.47
3	Anemia rate	17 414	%	27.2	22.7	4.51	<0.01
4	STH infection rate	2168	%	42.3	41.6	0.76	0.76
5	Working memory index points	4216	45–150 points	77.8	78.7	–0.96	0.01
6	Processing speed index points	4216	45–160 points	86.1	87.7	–1.59	<0.01
7	Standardized math test scores	19 580	SD	0.01	-0.00	0.01	0.60
8	MHT scores	21 015	0–90 points	36.3	36.4	–0.04	0.92

Source: Authors' data.

Notes: See Table 2 for complete definitions of all variables. *t*-tests are used to compare group means and calculate the P-values. Columns (5) and (6) are the mean values of the outcome variables. When the outcome variable is a dummy variable (e.g. anemia: 1 = being anemic; 0 = otherwise), the group mean is converted from group mean to percentage points (times by 100). SD, standard deviation.

In order to ascertain whether there are differential impacts of having siblings between the genders, we split our sample to examine the differences between only children and children with siblings among children of the same gender. With the exception of anemia rates, there are no statistically significant differences between male children with siblings and male only children in measures health or nutrition status (Table 6). All other indicators of health, cognition, and non-cognitive outcomes are statistically indistinguishable between male only children and male children with siblings. In contrast, there are statistically significant differences between female children with siblings and female only children in terms of health or nutrition status and cognition (Table 7). Therefore, the differences that are observed between the cognition variables for only children and children with siblings are clearly being driven by the differences between female only children and female children with siblings.

IV. Discussion

The primary aim of this study has been to document whether rural Chinese children with siblings are worse off than their only children counterparts in terms of health, cognitive, and non-cognitive outcomes. We find that children with siblings perform at least as well as only children in terms of health (four indicators), cognition (three indicators) and non-cognitive outcomes (one indicator). Specifically, in the cases of WAZ, HAZ, STH infection rates, standardized math test scores, and mental health test scores, children with siblings and only children performed the same. In the case of the rate of anemia, working memory and process speed measures, children with siblings performed better

Table 6. Comparisons of Health, Cognitive and Non-Cognitive Outcomes of Male Only children and Male Children with siblings in Rural China

(1) Outcome number	(2) Outcome	(3) Sample size	(4) Unit	(5) Male only children N = 1882	(6) Male children with siblings N = 11 923	(7) Difference (5) –(6)	(8) *p*-value
1	WAZ	785	Z-score	–0.68	–0.63	–0.05	0.62
2	HAZ	2266	Z-score	–0.91	–0.97	0.06	0.33
3	Anemia rate	9362	%	28.1	22.7	5.34	<0.01
4	STH infection rate	1168	%	41.2	44.0	–2.83	0.39
5	Working memory index points	2274	45–150 points	78.0	78.2	–0.25	0.60
6	Processing speed index points	2274	45–160 points	85.8	86.4	–0.57	0.36
7	Standardized math test scores	10 412	SD	0.04	0.04	0.00	0.93
8	MHT scores	11 173	0–90 points	35.7	35.1	0.60	0.21

Source: Authors' data.

Notes: See Table 2 for complete definitions of all variables. *t*-tests are used to compare group means and calculate the *p*-values. Columns (5) and (6) are the mean values of the outcome variables. When the outcome variable is a dummy variable (e.g. anemia: 1 = being anemic; 0 = otherwise), the group mean is converted from group mean to percentage points (times by 100). SD, standard deviation.

Table 7. Comparisons of Health, Cognitive and Non-Cognitive Outcomes of Female Only Children and Female Children with Siblings in Rural China

(1) Outcome number	(2) Outcome	(3) Sample size	(4) Unit	(5) Female only children N = 943	(6) Female children with siblings N = 11 123	(7) Difference (5) –(6)	(8) *p*-value
1	WAZ	660	Z-score	–0.48	–0.74	0.26	0.02
2	HAZ	1935	Z-score	–1.00	–0.99	–0.01	0.85
3	Anemia rate	8052	%	25.4	22.6	2.81	0.06
4	STH infection rate	1000	%	44.4	39.1	5.33	0.19
5	Working memory index points	1942	45–150 points	77.4	79.3	–1.84	<0.01
6	Processing speed index points	1942	45–160 points	86.6	89.0	–2.47	<0.01
7	Standardized math test scores	9168	SD	–0.06	–0.05	–0.01	0.75
8	MHT scores	9842	0–90 points	37.7	37.7	0.05	0.94

Source: Authors' data.

Notes: See Table 2 for complete definitions of all variables. SD, standard deviation. *t*-tests are used to compare group means and calculate the *p*-values. Columns (5) and (6) are the mean values of the outcome variables. When the outcome variable is a dummy variable (e.g. anemia:1 = being anemic; 0 = otherwise), the group mean is converted from group mean to percentage points (times by 100).

than only children. When examining the data by gender, we find, with the exception of anemia rates, that health, cognitive and non-cognitive outcomes of male children with siblings are statistically indistinguishable from those of male only children. Likewise, all health outcomes of female children with siblings are statistically indistinguishable from those of female only children. In the case of two of our measures of cognition, working memory and processing speed, female children with siblings performed better than female only children. However, female children with siblings and female only children are statistically identical on the standardized math test and mental health test.

Due to the fact that our results suggest that children with siblings do not lag behind their only children peers, there appears to be a fundamental shift in China. The gaps among school-aged children with and without siblings appear to have almost disappeared. This has been the case between children with siblings and only children from the same communities, in particular. The gap in cognition performance has not only reduced or disappeared, but in certain cases has also reversed itself. While it is beyond the scope of our paper to identify the exact mechanisms behind these shifts, they may be due to some combination of rising incomes and better off-farm employment opportunities.

This study makes a number of contributions to the literature concerning the associations between household composition and child development in rural China. First, the large size of the aggregated sample, comprising three different datasets, is much larger (n = 25 871) than those used in similar studies. This gives the study a high degree of statistical power and considerable external validity: at least for relatively poor regions of rural China. Second, all of the observations were collected by a single research team that used a common sampling strategy. The data collection instruments and the enumeration protocols were both standardized, allowing us to take advantage of the full, aggregated sample in our analyses.

This study was also potentially constrained by several limitations. First, given the nature of the sample, it is not possible to extrapolate our findings to China's non-poor areas. Second, although the paper compares children with siblings and only children on a number of different outcomes, we are unable to identify the exact cause of any observed differences and, therefore, can only report on statistical correlations.

The results in this paper should not be construed to mean that children in China's poor areas are not vulnerable. Indeed, the absolute levels of health, cognition and non-cognitive outcomes among both rural children with siblings and only children are still low. In comparison with international standards, all children in rural China are shorter and lighter than average children of the same age. In addition, over 40 percent are infected with intestinal worms. Other work has documented the poor levels of educational performance among rural children relative to urban children (Wang *et al.*, 2011). Perhaps a more accurate interpretation of the results of the present paper is that all children in rural China, no matter whether they are children with siblings or only children, are vulnerable and, therefore, require extra care, attention, and resources.

From our results we can assume that the end of the One Child Policy in 2015 will not cause the health, cognition, and non-cognitive performance of children in rural

China to deteriorate. From a policy perspective, our results may indicate the success of existing programs that aim to improve outcomes for rural Chinese children with siblings. In the future, additional research should focus on measuring the impact of such programs. If positive impacts are identified, this offers support for the idea that such programs should be expanded to cover all children in rural China.

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