

Wang, Qing; Zhang, Shiyong

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Gender Inequality in Nutrition Intake: Evidence from a Large Assistance Program

Qing Wang ^{*} Shiying Zhang [†]

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Abstract

This paper examines the growth effect of one of the largest nutrition assistance programs in early life. The program covers 5.8 million children in poor rural China and provides 6-24-month old children with a free nutrition supplement that contains nine essential micronutrients. We utilize a phase-in procedure by county for identification and estimate its impact on several early-life health indicators. Robust evidence shows that such nutrition supplements effectively increase boys' weight and reduce their probability of being underweight. No effect is observed on girls of similar age. These health indicators are related to long-term human capital development. The gender differences in policy impact that are identified in this paper have important implications for nutrition subsidy in the early years of life in developing countries.

Keywords: Nutrition, complementary feeding, health, children, poverty

JEL Classification: I10, I18

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^{*}International School of Business and Finance, Sun Yat-sen University; Rural Development Institute, Yan'an University. Email: wangq577@mail.sysu.edu.cn.

[†]School of Economics and Management, Harbin Institute of Technology Shenzhen; Global Labor Organization. Email: zhangshiyong@hit.edu.cn.

1 Introduction

Undernutrition is a predictor of many developmental constraints, which include cognitive deficits and reduced economic opportunities. Developing countries have been making substantial efforts to improve the health and education of human capital by focusing on child nutrition. Since the 1990s, the worldwide prevalence of stunting declined from 40 percent in 1990 to 22 percent in 2017. However, substantial regional differences persist, even within a country. Undernutrition is more common in rural areas and poor households because income is a key determinant. Fortunately, the losses of malnutrition are largely preventable if adequate government interventions are made, especially those that focus on ensuring optimal nutrition in the critical 1000-day window between the start of a woman's pregnancy and her child's second birthday. Subsidized and free nutrition supplements for children has been provided in many developing countries, e.g., the fasevie project in Vietnam (Van Hoan et al., 2009; Phu et al., 2010), vitamin D fortification in India (Khadilkar et al., 2007; Sahu et al., 2009), and wheat strengthening with iron, zinc, folic acid and vitamin B in Indonesia (Fahmida et al., 2007).

China has been making substantial efforts to reduce poverty, especially in rural areas. According to the Chinese standard poverty line in 2010, the proportion of people in poverty declined from 49.8% in 2000 to 17.2% in 2010 and further reduced to 1.7% in 2018.¹ This implies that nearly 150 million people in China were lifted out of poverty during the last decade. The poverty alleviation instruments have potential effects on the improvement of children's health statuses. For example, Chen et al. (2017) show that the tax-for-free reform in rural China increases the height-for-age z-score and weight-for-age z-score of children. However, various health problems of rural children remain. From 1990 to 2010, the growth retardation rate of children in rural areas was approximately 3-4 times that in urban areas, and that in poor rural areas was twice that in general

¹According to the level of social and economic development, China adjusted the poverty alleviation standards in 1978, 2008 and 2010. The poverty line increased from 366 yuan in 1978 to 2952 yuan in 2016 (in 2010 prices). The poverty line in 2000 was 625 yuan, and the number of poor people was 32.09 million. According to the 2008 standard, the poverty line in 2000 was 865 yuan, and the poverty population was 94.22 million. In 2010, the poverty line was 1274 yuan, and the number of people in poverty was 26.88 million.

rural areas. Up to 2010, 20% of children under the age of 5 in poor rural areas were still stunted. The prevalence of anemia in Chinese children aged 6-12 months remained as high as 28.2%, and that of children aged 13-24 months was 20.5%. The prevalence of developmental delay among preschool-aged children calls for more direct interventions in the early years of life (Wei et al., 2015).

In view of the widespread malnutrition of children in poverty-stricken counties in China, the government launched a large-scale nutrition improvement project in these areas in 2012. The nutrition supplement (*Ying Yang Bao*) for infants and young children uses soybean as the matrix and contains 9 micronutrients (vitamin A, vitamin D, vitamin B1, vitamin B2, vitamin B12, folic acid, iron, zinc and calcium according to Table Appendix 1). One nutrition package per day is used to supplement nutrients for infants and young children aged 6-24 months in the target poor areas. The project initially covered 270,000 children in 100 selected poor counties in 10 provinces. Six year after the initiation, in 2018, the nutrition project covered 715 poor counties and 7.2 million children. These counties are located in 14 concentrated and contiguous areas in 21 provinces. As of 2020, all 832 poor counties are included in the project.

In this paper, we evaluate the effects of the widespread nutrition assistance program on the growth of children under six years old. We explore the variation of program initiation at the county level for identification. In light of the growth differences between the genders, all empirical models are estimated separately for boys and girls (Kong et al., 2019). As a preview of the results, we find that nutrition supplements moderately improve children's growth charts by increasing the weight-for-age and reducing the incidence of being underweight. We also find that the effects across children differ markedly by gender. No evidence of growth impacts on girls is observed in any empirical specification.

We attribute the gender-specific findings to the compliance behavior of parents, which was influenced by their son preference. As son preference prevails in China and many families face constraints in terms of income and education², prior studies show that

²The son preference also results in a high sex ratio (the number of males per 100 females) at birth due to the one child policy in China (Ebenstein, 2010; Li et al., 2011)

migrant households invest heavily in boys instead of girls when institutional arrangements result in high costs of schooling for migrants (Liu et al., 2018). Intergenerational coresidence and household time allocation are affected by son preference as grandparents derive higher utility from grandsons than granddaughters in the public good dimension (Sun et al., 2019). Here, we document evidence of son preference and gender difference in maternal investment along with nutrition intake. We find that maternal breastfeeding increases with exposure to supplementary nutrition intake for boys but increases insignificantly or even decreases for girls. The gender-biased preference in breastfeeding will undoubtedly reduce the effect of the nutrition package because the micronutrient supplement must be taken along with breastfeeding (Yue et al., 2019; Luo et al., 2014).

This paper contributes to the literature in the following areas: First, findings in this paper add to the expanding literature on nutrition intervention in developing countries. Prior studies in other fields suggest positive impacts of nutrition assistance, for example, the fasevie project in Vietnam, the nutrition power project in India, and the high phytic acid content school diet in Indonesia. The fasevie project in Vietnam improves the health status of infants and reduces the prevalence of anemia, iron deficiency, zinc deficiency and iron deficiency anemia (Bruyeron et al., 2007). Studies on nutrition power in India show that the iron status of children is improved (Osei et al., 2010). In Indonesia, due to the potential high phytic acid content in the school diet (which is composed mainly of rice and lentils), the impact of the project on children’s zinc deficiency is not readily observable (Hotz and Brown, 2004). A common weakness of these studies is that they show evidence of correlation. There is a lack of impact evaluation on the causal effect of a government’s intervention in nutrition in early life. We add to the literature by providing causal evidence based on a large-scale program in China.

Second, studies on China’s nutrition intervention program frequently use small-scale samples and evaluate short-term policy impacts, namely, impacts within a couple of years. They obtain mixed results on policy impacts because the sampling designs and field experiments may be conducted in regions that differ substantially. For example, various small-scale studies show that the nutrition package can improve the diversity of

intestinal flora of infants and promote the balance of intestinal flora in the intervention areas (Wang et al., 2020), reduce the 2-week prevalence of fever and diarrhea (Chen et al., 2020), improve the intake of vitamin A and vitamin D (Li et al., 2019), and improve the anemia and malnutrition statuses of infants and promote the physical development of infants and young children (Zhang et al., 2019). In contrast to these studies, we use a national representative sample of rural counties, conduct a large-sample analysis of the nutrition package program and evaluate its average impact across the nation for a longer period (up to school-age). The findings of this paper facilitate understanding of the average effect nationwide and cost-benefit analysis.

Third, in this study, we investigate how nutrition assistance promotes the growth of boys and girls differently and discuss plausible mechanisms. Recent studies show the crucial role of parenthood on children’s developmental outcomes (Kleven et al., 2019; Kuziemko et al., 2018). Prior studies on nutrition supplements in China also suggest that parental preference and behavior may affect the impacts of nutrition packages on children. For example, text message reminders and encouragement from fellow villagers both affect the use of nutrition packages in a survey in Shanxi Province (Wang et al., 2018). Our findings extend these interpretations and shed light on parental behavior and communication changes from a gender perspective.

The remainder of the paper is organized as follows: Section 2 reviews the literature and institutional background. Section 3 describes the data and empirical strategy. Section 4 presents the results and Section 5 the conclusions of this study.

2 Background

2.1 Malnutrition and children’s health

Researchers have been focusing on the effects of the first 1000-day nutrition intervention on socioeconomic outcomes in childhood and adulthood. Malluccio et al. (2009) examine a long-term randomized experiment that provides 0-to-7-year-old children in Guatemala a high-protein energy drink. They show that the children who received the interven-

tion realize increased schooling attainment and have increased cognitive ability in their school-age. Hoddinott et al. (2008) investigate the same intervention and find that nutritional supplements in the first two years of life increase male wages by 46 percent. These large effects suggest that an early diet intervention can have important long-term consequences. Quasi-experimental studies also provide evidence on the importance of various nutrients. In a prominent example, Field et al. (2009) examine the effects of fetal exposure to iodine supplementation as part of a large but episodically implemented government program in Tanzania. Iodine deficiency in pregnant women has been linked to mental retardation in affected fetuses but has been virtually eliminated in developed countries. Field et al. (2009) find that children who benefit from the supplements in utero experience large gains in educational attainment. The effects are larger for girls than for boys, which is consistent with scientific evidence that female fetuses are more vulnerable to damage from iodine deficiency.

Other popular early-life interventions include malaria exposure prevention and deworming. Using data from the U.S. and South and Latin America, Bleakley (2010) estimates that 100 percent eradication of malarial infections increases subsequent adult income by 47 percent in the US, 45 percent in Brazil, 45 percent in Colombia, and 41 percent in Mexico. Bleakley (2010) also finds positive effects on literacy but mixed results for years of schooling. In contrast, Cutler et al. (2010) examine India's malaria eradication campaign of the 1950s and detect no effect on educational attainment. Complementing Bleakley's (2007) study on the historical United States, several studies examine the effects of deworming on medium and long-term outcomes in developing countries. In a well-known paper, Miguel and Kremer (2004) analyze the experimental introduction of deworming treatments into Kenyan schools.

2.2 China's poverty alleviation and nutritional improvement

2.2.1 Poverty-stricken county in rural China

China has been making substantial efforts to reduce poverty. In 1986, the government established a special poverty alleviation organization, namely, the State Council's Lead-

ing Group for Economic Development in Poverty-stricken Areas (which was renamed as the State Council's Leading Group for Poverty Alleviation and Development in 1993). Similar local organizations have been established in various places. At the same time, the government designated poverty-stricken counties at the national level and allocated special funds and instituted preferential policies for poverty alleviation. By 1993, the rural poverty population had dropped to 80 million, with an average annual decrease of 6.4 million. In March 1994, the government formulated the 8-7 Poverty Alleviation Plan, which aims at solving the food and clothing problems of 80 million poor people in seven years. At the end of 2000, the target was reached on schedule, and the number of poor people fell to 32 million, which corresponds to an average annual decrease of 12.3%. In 2001, the government formulated the "China Rural Poverty Alleviation and Development Outline (2001-2012)" and shifted the focus of poverty alleviation to the village level by coordinating rural economic and cultural construction. The rural tax and fee reform was implemented in 2001; the rural cooperative medical system was implemented in 2003; and the agricultural tax was ended in 2006. Meanwhile, the government started to construct a new countryside and established the rural minimum living security system in 2007. Furthermore, an urban-rural integration development strategy was implemented in 2008. By 2010, the number of rural poor had dropped to 26.88 million.

In December 2011, the government formulated the "China Rural Poverty Alleviation and Development Program (2011-2020)" and delineated 14 difficult poverty areas (Figure 1). In this stage, the targeted poverty alleviation measures included "six precision", "five in one batch", "ten poverty alleviation projects" and "six actions".³ From 2014 to 2017, the targeted poverty alleviation measures reduced the rural poverty-stricken population from 82.49 million in 2013 (the poverty line rose to 2736 yuan) to 43.35 million in 2016 according to the department of household surveys of the National Bureau of Statistics of China, and the corresponding proportion of the poverty-stricken population decreased from 8.5% to 4.5%. In 2015, the per capita income of rural residents in poor areas was 7653 yuan, which was 2.9% higher than the average level of rural residents in China.

³<http://www.scio.gov.cn/xwfbh/xwfbh/wqfbh/2015/33909/zy33913/Document/1459275/1459275.htm>

In 2017, the 19th National Congress of the Communist Party of China stressed the key task of poverty alleviation in deep poverty-stricken areas and put forward the Rural Revitalization Strategy to ensure that all rural residents who were below the current poverty line would be lifted out of poverty by 2020. By 2018, the number of people living in poverty dropped to 16.6 million. Among the 832 poverty-stricken counties, 28 were lifted out of poverty in 2016 and 125 in 2017. In July 2019, the Poverty Alleviation Office of the State Council announced that there were 283 poverty-stricken counties. A total of 436 poverty-stricken counties had been lifted out of poverty, which accounted for 52.4% of all poverty-stricken counties, by May 2019. The most recent data show that a total of 780 counties had been lifted out of poverty by May 2020.

2.2.2 Nutrition package project

The first 1000 days of life constitute the most critical period of growth from pregnancy to the age of two. The lack of micronutrients in this early stage of life would have irreversible and irreparable impacts on children's health and development, e.g., on the ability of children to learn in school and their productivity in adulthood. According to a baseline survey of six counties in Shanxi, Hubei and Yunnan in 2012, 4% of infants were of low weight, 10% exhibited growth retardation, 32.9% were anemic, and 2% were overweight. The problem of micronutrient deficiency is more prominent in China's poor rural areas. Micronutrients, especially iron, vitamin A, zinc, iodine and folic acid, are essential for children's development and health.

As a crucial component of the "China Rural Poverty Alleviation and Development Program (2011-2020)", the government implemented relevant policies to promote health, reduce poverty, and promote the early development of 0-to-3-year-old children in these poor areas. A large-scale project that targets children prior to kindergarten is named "*Ying Yang Bao*", which is used to prevent and control iron and other micronutrient deficiencies. The nutrition improvement project aims at increasing the nutrition investment during the first 1000 days of life and provides free nutrition packages for 6-24-month old children in poor areas. It is regarded the most cost-effective way to invest in 0-to-2-year

old children in poor areas. The nutrition project uses a phase-in procedure. In 2012, the project selected 100 poor counties from 10 provinces and covered 270,000 6-to-24-month-old children. The 100 counties are clustered in the Luliang Mountain Area in Shanxi Province, the Wuling Mountain Area in Chongqing, Hunan and Hubei Provinces, the Wuling Mountain Area in Guizhou Province, the Wumeng Mountain Area in Guizhou Province, the western Yunnan border mountain area, the Yunnan Tibetan area, the Lipu Mountain Area in Qinghai Province, and three prefectures in Tibet and southern Xinjiang (Figure 1). In 2013, the nutrition project was expanded to 830,000 infants in 300 counties from 21 provinces. In 2014, the project covered 1,370,000 6-to-24-month-old children in 341 counties from 21 provinces.

From 2015 to 2016, a small-scale evaluation of the project was conducted. The compliance rate for the nutrition package was 74.5%, which exceeded that in 2014, namely, 52%. Thus, parental recognition and acceptance of the nutrition package have been substantially improved. The incidence of adverse reactions to the nutrition package was 7.6%, and the main adverse reaction was diarrhea. Most of the parents chose to stop feeding the nutrition package for a few days after discomfort. However, only less than half of the parents of infants and young children could feed the nutrition package correctly; hence, the education on nutrition package feeding must be strengthened according to the Institute of Nutrition and Health, China Center for Disease Control and Prevention.

Earlier evaluation results on the policy impacts on health outcomes in selected areas are as follows: According to the national food nutrition monitoring data in 2013, the prevalence of anemia among children under five years old in rural areas decreased from 12.6% in 2010 to 10.9% in 2013. The study on the effectiveness of the nutrition package intervention in poor areas also demonstrated that nutrition package positively affected children's development quotient and IQ. According to the monitoring results of the project in 2017, the compliance rate for the nutrition package in the project area reached 75.5%, and the average anemia rate and growth retardation rate of infants aged 6-24 months in the project continuous monitoring area decreased to 17.6% and 6.4%, respectively, according to the National Health Commission. The low weight rate and

growth retardation rate, which are the main indicators of nutritional deficiency in infants and young children, decreased to 3.9% and 7.6%, respectively. The overweight rate of infants and young children increased to 3.8%, and the problem of excessive nutrition began to appear. The anemia rate of infants and young children decreased to 26.3%, but the anemia rate of the 6-to-11-month-old group remained high and reached 33.9%. This may be related to the untimely delivery of the nutrition package.

In June 2018, the CPC Central Committee and the State Council issued guiding opinions on the three-year action for poverty alleviation. According to the opinions, the children’s nutrition improvement project in poverty-stricken areas must be extended to all poverty-stricken counties. By the end of 2018, the central government had invested approximately 2.8 billion yuan, and the program covered 715 counties (cities and districts) in 21 provinces and 7,220,000 6-to-24-month-old children. In July 2020, the nutrition improvement project for children in poverty-stricken areas realized full coverage of all 832 national poverty-stricken counties according to the National Health Commission.

3 Method

3.1 Data

We use data from the China Family Panel Studies (CFPS) to construct the empirical analysis. CFPS is a large-scale, nationally representative, longitudinal survey that was conducted by the Institute of Social Science Survey of Peking University. The baseline survey in 2010 surveyed 57,155 respondents from 14,960 households in 649 communities or villages in 162 counties and 25 provinces. These provinces contain 95% of the population in China. The survey questions cover a wide range and include health, demographics, family background, and many community characteristics. We use all wave surveys from 2012, 2014, 2016, and 2018.⁴ The regional variables are obtained from provincial and county statistical yearbooks. The variables of financial access are obtained from the Digital Finance Research Center at Peking University.

⁴Wave 2010 is dropped from the analysis because we focus on children who were born in 2010 and later years.

3.2 Sample

We select children who were born between 2010 and 2016 and construct the main sample for the analysis. These children were less than two years old when the central government first announced the nutrition project in 2012 and were potentially eligible to participate in the nutrition program based on age. We further require that they were at least 24 months old at the time of the survey to ensure that the treatment has been completed. Therefore, observations of these children are obtained from CFPS 2012, 2014, 2016, and 2018. The sample for analysis consists of 3159 observations from 1718 boys and 1441 girls who were between 24 and 72 months old at the time of survey. Observations from urban respondents are dropped from the main sample for analysis due to the substantial regional heterogeneity in child health outcomes and family and social aspects between rural and urban areas. Moreover, the nutrition improvement program that is being analyzed targets only rural areas and not urban areas. However, we use the urban sample of children who were born between 2010 and 2016 and aged 24-72 months for falsification testing in the following section.

The distribution of counties that were included in the nutrition supplement program in CFPS is available upon request. We compare it with the distribution of poor counties in 14 contiguous areas of extreme poverty in Figure 1 and find that the treatment counties in the sample are geographically representative of the poor counties at the national level. We almost have one county selected from each of the contiguous areas that participated in the nutrition program in the sampling period. A similar number and distribution of treatment counties are used in Cai (2020).

3.3 Variables

3.3.1 Dependent variables

Importantly for this paper, the CFPS records anthropometrical measurements, height and weight for each child respondent. Child anthropometric measurements provide useful information on child health status according to studies on children’s health in developing

countries. They are easy to obtain and are comparable across ages and sexes (Chen & Li, 2009). First, we define the height-for-age (HAZ), which is the Z-score that is calculated as the difference between the actual height and median height divided by the standard deviation in the reference population (children of the same age and gender). The median and standard deviation of height in the reference group are obtained from the World Health Organization (WHO) Multicentre Growth Reference Study.⁵ HAZ is a satisfactory health indicator as it is a measure of both short- and long-term health status (Strauss and Thomas, 1998; Behrman and Rosenzweig, 2002). We define the weight-for-age (WAZ) similarly to evaluate the possible weight gain effects of the policy intervention.

Since the effects on height and weight represent only average effects on the overall population, it is important to investigate how children at the margin are also affected. Being stunted is regarded as the measure of long-term nutritional deficiency, and underweight reflects acute shortages of food (Liu et al., 2013). Examining the effect on underweight children is especially crucial since the issues of malnutrition and underweight children remain in rural areas. In the late 1990s, China had a higher proportion of underweight children (13%) than other developing countries with dual-burden households, such as Russia (8%) and Brazil (9%) (Wang et al., 2002). As weight is easy to measure, this is the indicator for which the most data have been collected in the past. Evidence has shown that the mortality risk of children who are even mildly underweight is increased and that severely underweight children are at even higher risk. Underweight children suffer from stunted growth, poor immune systems, and a high likelihood of bone fractures (Walker et al., 2007). Even though the percentage of underweight children declined by 74% to 3.6% between 1990 and 2010, the percentage remains especially high in rural areas at approximately 8% according to Ministry of Health. Children who suffer from growth retardation as a result of poor diets or recurrent infections tend to be at higher risk for illness and death. Stunting is the result of long-term nutritional deprivation and often results in delayed mental development, poor school performance

⁵The standard is available at https://www.who.int/childgrowth/standards/height_for_age/en/.

and reduced intellectual capacity. This, in turn, affects economic productivity at the national level.

We classify a child as being underweight if the child’s weight-for-age is below 2 standard deviations from the WHO Child Growth Standards median. A child is classified as being stunted if the child’s height-for-age is below 2 standard deviations from the WHO Child Growth Standards median. The WHO growth standard is used as a general reference in the literature on child development in China and other developing countries (Kong et al. 2019). In addition to the WHO standard, we can define being underweight and stunted according to Centers for Disease Control and Prevention (CDC) growth chart for ages above 2 years.⁶ Although the Chinese-specific cutoffs or international cutoffs that were developed by the International Obesity Task Force (IOTF) may seem more suitable for this paper, the IOTF cutoffs are not intended to replace national reference data (Flegal et al., 2006). Moreover, the IOTF chart provides no cutoffs for underweight children. For these reasons, we define the growth measures based on the WHO standard in the main analysis, and we present findings based on the CDC and Chinese cutoffs for robustness. The Chinese criteria are calculated by using the entire representative CFPS sample via a similar approach to that of Liu et al. (2013).

3.3.2 Control variables

We control for individual, family, and regional characteristics. Individual-level control variables include maternal education, child’s age (in months), squared age (divided by 100), gender, race, birth weight, birth order, and year of survey. Paternal education is omitted due to the high correlation between maternal and paternal educational attainment. Moreover, maternal education has a dominant effect on children’s health according to the literature (Wang et al., 2020). Maternal education is specified as a category number and ranges from no education (lowest number) to post-graduate education (highest number). Male is a dummy variable that indicates that a child being analyzed is a boy. Han is a dummy variable that indicates that the child is not in a minority group. Birth

⁶The National Commission of Health released a set of criteria for child and adolescent overweight and obesity in 2018.

order indicates whether a child is the first child in the family.

Our empirical method, as discussed below, assumes that no other confounding factors affect the outcomes that occurred at the same time as the nutrition program. To relax this assumption, we add variety of county- and provincial-level variables. First, we control for per capita GDP and the development level of inclusive finance (both in logarithm) at the county level to absorb the heterogeneity of local development and government assistance to financial services in poor areas. The county-level control variables also help capture the potential influence of income growth that is generated by other poverty reduction programs and inclusive finance programs. The provincial-level control variables include the birth rate (%), health expenditure (in logarithm), and employment in the tertiary sector (%). The birth rate and health expenditure may influence the human capital investment to children in a region. The employment share in the tertiary sector may influence the maternal employment opportunity.

3.4 Empirical specification

We employ the exogenous variation in the program start time across counties to identify the effects of nutrition assistance on children’s health outcomes. We model the health outcomes y of infant or child i in county c and survey year t as follows:

$$y_{ict} = \alpha + \beta treatment_{ict} + \gamma X_{ict} + \theta_c + \lambda_t + \epsilon_{ict} \quad (1)$$

The measures of the health outcomes y were described in detail in the previous section. Variable $treatment_{ict}$ represents the intended policy intensity that was received by child i in county c by survey year t . The policy intensity is measured as the calculated length of welfare coverage. The nutrition package is provided to children aged 6 to 24 months. Information on the year and month of birth is available in CFPS. For children in counties that are covered by the nutrition project, we construct their age in months and calculate the distance between the age in months and 24 months. The gap divided by 18 is bounded between 0 and 1 and represents the continuous policy exposure that a child

receives. For children from counties that are not covered by the nutrition program, the variable $treatment_{ict}$ is assigned a value of zero; hence, $treatment_{ict}$ is analogous to an interaction term in a typical difference-in-differences framework.

β in Equation (1) represents the causal effects of the nutrition package on children’s health status indicators, such as height and weight. It measures the intent-to-treat (ITT) effect because we estimate the reduced-form effects on all rural children who are covered by the nutrition program rather than just on those who actually utilize the nutrition package. However, as discussed above, the takeup rate of nutrition package reached approximately 75%, which is a very high compliance level. Thus, the treatment effect on the treated (TOT) should be very close to the ITT ($TOT=\beta/0.75$). We report only the reduced-form effects throughout the paper.

X_{ict} is a set of variables that represent child, family, county and province characteristics. We control for age, squared age, ethnic group (Han or minority group), birth order (first child), and maternal education (in the education category) in the regressions. Age should not be significant in the regressions by default because dependent variables HAZ and WAZ have been adjusted according to age. Age and squared age are included in Equation (1) to examine whether age has a nonlinear impact on the outcome variable. The per capita GDP at the county level, sex ratio, health expenditure, and tertiary sector share are controlled to address the concern regarding confounding factors at the aggregate level. They are used to absorb the local heterogeneity in income and children’s health. In addition, we control for county fixed effects θ_c and year of survey fixed effects λ_t . The year of birth is automatically controlled for because both the age and survey year are included in Equation (1). Standard errors are clustered at the provincial level to account for the correlation of individuals within a region. Standard errors at the provincial level account for more unobserved correlations than those that are clustered in smaller geographic areas.

We conduct separate regression analyses for boys and girls based on Equation (1). The literature suggests important heterogeneity in terms of growth pattern and health outcomes between boys and girls, especially in developing countries (Vilar-Compte et

al., 2020). This helps account for the potential gender-specific impacts of unobserved factors (Kong et al., 2019).

4 Results

4.1 Main findings

Table 1 presents the summary statistics of variables of samples of boys and girls. The height-for-age is far below zero for the children, which implies that their height is below the average height of the children in the international sample that is used in the WHO standards. The HAZ for boys is slightly lower than the HAZ for girls. The gap is not statistically different from zero. The observation regarding weight-for-age is different. The average WAZ of children in China slightly exceeds the WHO median. Boys have a higher WAZ than girls in the sample (0.269 versus 0.165). A high proportion of children in the sample are stunted according to the WHO standards. This is consistent with the summary statistics on HAZ. Approximately 6% of boys and 4% of girls are underweight in the sample. Boys have a higher underweight rate (statistically significant).

The unconditional average treatment intensity is 0.07-0.08, and it is balanced between the boy and girl subsamples. Conditional on receiving at least some intervention, the program exposure is 0.727 versus 0.681 for boys and girls, respectively. The children in the sample (both boys and girls) are 45 months old on average. Maternal education is significantly higher for boys than girls (2.797 versus 2.711). In the sample, 97.4% of children are Han, and 78% of them are the first child in the family. The following rows present the selected measures of local economic conditions. We observe no difference in the county per capita GDP, provincial birth rate, health expenditure or tertiary industry proportion between the boy and girl subsamples. Finally, the remaining rows present the distribution of observations by year of survey. Again, the distribution is balanced between the boy and girl subsamples.

First, we present estimates that are based on Equation (1) for a sample of boys in Table 2. Overall, the nutritional intake that is generated by government assistance has

no effect on HAZ (Column (1)) or being stunted (Column (3)). However, the nutrition assistance in early life has increased the weight gain of 2-to-6-year-old boys. WAZ increases by 0.418 standard deviation if a boy takes the nutrition package for 18 months compared to that of a counterpart who takes no nutrition subsidy. If we set the average intensity at 0.07 according to Table 1, the weight gain is 0.03 times the standard deviation. At the margin, a complete treatment reduces the likelihood of being underweight by 12.3%. Again, the treatment intensity for boys is 0.07 according to Table 1. This implies that the nutrition subsidy project reduces the likelihood of being underweight by 0.86%.

Interesting findings regarding the control variables were obtained, which are presented as follows: Age seems to have no linear or nonlinear effect on being stunted or underweight because HAZ and WAZ are defined by using age- and gender-specific cut-offs. Maternal education tends to increase children’s height and reduces their likelihood of being stunted. The effect of maternal education on weight is unclear because its effect may occur through multiple channels (Yo and Wang, 2017). For example, maternal education increases income, and higher income may be used to purchase more calories and protein. In addition, a more educated mother has more health knowledge and may restrict the consumption of foods that are rich in calories. Being the first child in a family has a beneficial effect on children’s height. The development level of the local economy is likely essential to children’s growth because the signs of the coefficients of the per capita county GDP are consistent with the prediction. They are not significant because a large proportion of the variation has been absorbed by county fixed effects and year fixed effects. Similarly, the birth rate, health expenditure, and employment proportion in the tertiary industry are not significant because the province year trend and year fixed effects are included in the model. Finally, the proportion of children who are underweight or stunted continues to decline over the years. This indicates that the growth chart of children in China may be catching up with the WHO international standards.

In contrast, nutrition packages appear to have no effect on the girls’ growth chart

in Table 3, although the findings regarding the control variables are similar to those in Table 2. Various unique findings regarding the control variables for girls are as follows: Girls in minority groups were of lighter weight and had a higher probability of being underweight. The local economic development level seems more important for girls than boys. The girls' HAZ is lower when the provincial birth rate is higher, which indicates a potential son preference. Finally, the growth measures exhibit a clear time pattern of the improvement of the growth outlook over the years.

In Table 4, we further explore the nonlinear effects of the nutrition package by treatment category. Ideally, we can use a piecewise nonparametric model to identify the nutrition effects by month and, hence, determine the optimal treatment length. Given the relatively small sample size of children being treated, however, we define three groups: no treatment, low treatment (below the mean conditional on being treated), and high treatment (above the mean). Table 4 presents the growth effects of nutrition supplements by treatment category for longer and shorter than average treatment durations in months. The default omitted category is the control group, namely, no intervention. Overall, a longer period of treatment has larger effects on the WAZ and on being underweight for boys. Neither high intensity nor low intensity treatment results in growth gains for the sample of girls.

In Table 5, we use HAZ and WAZ values that are defined based on Chinese standards, and we classify children as being stunted and underweight based on CDC standards for robustness. When we define being stunted and underweight by using CDC cutoffs, columns (3) and (4) indicate that nutrition intake reduces the probability of being underweight by 13.7% if we compare a child with complete nutrition intervention and a child without any intervention. Again, we observe no policy impact on girls using Chinese or CDC standards.

4.2 Robustness

Table 6 presents the DD estimates that were obtained using a subsample that was restricted to poor counties to further reduce the heterogeneity between the treatment and

control groups. This subsample also helps account for other contemporaneous policies that have direct and indirect impacts on children’s growth, for example, public child-care and immunization. The signs and magnitudes of the coefficients are comparable to those in Table 2. The growth effect of the nutrition subsidy includes a 13.1 percentage points decrease in being underweight. Again, this implies an approximately 0.9% drop in being underweight. The size of the effect is highly similar to that in Table 2. The coefficient of WAZ becomes smaller and changes from 0.418 to 0.451. In Panel B, we add the province-by-year fixed effects and rule out the potential influence of the differential growth pattern among regions. The results are similar to those in Table 2.

Finally, we conduct two falsification tests and present the results in Table 7. Panel A in Table 7 shows how the growth chart changes differently between other poor counties (pseudo treatment counties) that are not covered by the nutrition program in 2016 and non-poor rural counties. By default, the children in the pseudo treatment counties receive no nutrition intervention even if they reside in national poor counties. This method examines whether other possible policies in the same period affect children’s health in poor counties. In none of the specifications does the coefficient of pseudo treatment, namely, the interaction of poor county and young cohort (children who were born in 2014 and later years), differ significantly from zero. Another falsification test in Panel B defines the treatment intensity by county and birth cohort using a similar method to Equation 1 for a sample of children in urban areas. This is a pseudo treatment because none of the urban areas are included in the nutrition supplement program. The results in Panel B demonstrate that the pseudo treatment has no impact on children’s growth.

4.3 Heterogeneity

Wang et al. (2018) evaluate whether text messaging is effective in improving caregiver adherence to micronutrient powder supplementation for infants aged 0-17 months in a small-scale survey in rural Shaanxi Province. They show that text message reminders increase the consumption of the nutrition packets. Furthermore, caregivers who were familiar with text message functions and mother caregivers were more responsive to text

message reminders. They also find that the willingness of caregivers to feed the nutrition kits, the degree of preference of infants, the praise of fellow villagers and the observation by caregivers of changes in their children’s health status were important factors that affected compliance regarding supplementation with infant nutrition packages. According to Table 8, the nutrition policy is more effective among children whose mothers are less educated.

4.4 Discussion of the mechanism

This paper evaluates a large-scale nutrition program that distributes nutrition supplements through local health centers. By default, the policy impact could be lower than prior local small-scale RCTs that distributed nutrition supplements via home delivery (Luo et al., 2017). Previous studies on small-scale RCTs showed mixed results regarding the effects of nutrition packages on children’s health (Zhang et al., 2015). Hence, the role of caregivers is an important moderator in the intervention. Finally, we examine the reason for the gender-specific policy impact in Table 9.

Breastfeeding can improve children’s cognitive abilities (Anderson et al., 1999), reduce the incidences of dysentery, respiratory infection, asthma and other diseases (Heinig, 2001; Gdalevich et al., 2001), and reduce childhood obesity (Butte, 2001; Burke et al., 2005). Breastfeeding also benefits mothers’ postpartum recovery, reduces the risks of cancer and cardiovascular disease, and reduces postpartum depression (Schwarz et al., 2009). The United Nations International Children’s Emergency Fund (UNICEF) and the World Health Organization (WHO) recommended an exclusive breastfeeding⁷ duration of 6 months and a total breastfeeding duration of 2 years in 2003. China has a low breastfeeding rate. According to the report of “Factors Affecting Breastfeeding in China” that was produced by the China Development Research Foundation in 2019, the exclusive breastfeeding rate for 0-to-6-month-old children is 29.2%, and the breastfeeding rate for 11-month-old children is 66.5%. The rate for 0-to-6-month-old children is much lower

⁷Exclusive breastfeeding refers to feeding the baby no water, liquid or food other than breast milk within 6 months (180 days) after birth. After 6 months, supplementary food can be added timely, sufficiently and safely, and breastfeeding can continue until the age of two or more (natural weaning).

than the goal of 50% that was set by China’s National Nutrition Plan in 2017. Prior studies have documented a gender gap in the length of breastfeeding (Jayachandran and Kuziemko, 2011). Micronutrient supplementation or home fortification is recommended along with breastfeeding (Yue et al., 2019; Luo et al., 2014; Luo et al., 2015).

According to Table 9, maternal breastfeeding increases with exposure to supplementary nutrition intake. For example, complete nutrition supplementation for 18 months increases the length of breastfeeding by 20.2% for boys according to Column (1). Breastfeeding for girls is not impacted by exposure to nutrition supplements according to Column (2). The effect is amplified when a restricted sample of poor counties is used (Columns (3) and (4)). We find that nutrition supplements extend the duration of breastfeeding by 28.3% for boys and shorten the breastfeeding duration by 16.8% for girls. Hence, Table 9 suggests that a mother may regard breastfeeding and the nutrition package as complements for a son. In contrast, she may regard breastfeeding and the nutrition package as substitutes for a daughter. Overall, mothers do not provide sufficient breastfeeding along with the nutrition package for girls. This is consistent with the long-lasting son preference in rural China, which has been well documented in the literature (Lin et al., 2018).

5 Conclusions

Young children are especially vulnerable to nutritional deficiencies. *Ying Yang Bao* is a soybean-based product that is designed for the fortification of complementary feedings. It is distributed to families through the Maternal and Child Health Care channels in selected counties during the intervention period. This nutrition supplement is suitable for mass production, distribution, and marketing (Chen et al., 2013).

Using the nutrition package program in China as a large-scale quasi-experiment, we estimate the effects of the nutrition supplement during the early formative childhood years on height and weight for 2-to-6-year-old children and the underlying mechanisms through maternal investment. We exploit a longitudinal data set and variation in nutrition assistance across county and birth cohorts for identification. We find that the

policy-induced supplementary nutrition increases the weight of boys and reduces their likelihood of being underweight. In contrast, the supplementary nutrition has no effect on rural girls of similar age. Hence, our study sheds light on the differential policy impacts by gender. We further determine that parental behavior and son preference may explain the observed gender gap.

Luo et al. (2017) conduct a cluster-randomized controlled trial in Shaanxi province, in which all children aged 6–11 months in poor villages are enrolled and outcomes are tracked every 6 months over 18 months. They determine that multiple micronutrient powders significantly increase the infants’ hemoglobin levels and cognition levels after 6 months of supplementation. However, these positive effects disappear after children get older. Our findings are similar. The weight gain from nutrition fortification remained for a longer period. However, the height gain disappeared for children aged 24–72 months.

Our results suggest that a breastfeeding gap may account for the gender gap in policy impact. Due to the short-term and long-term health benefits of breastfeeding, which have documented in the medical and public health literature, the findings in this paper also have implications for breastfeeding and health. Early weaning of daughters is an unintended consequence of public nutrition assistance. Access to infant formula has negative effects on breastfeeding duration (Demir et al., 2020). Among the social drivers of breastfeeding, son preference is shown to affect breastfeeding practices and favorably affects boys in Egypt and India (Chakravarty, 2015; Demir et al., 2020; Jayachandran and Kuziemko, 2011).

The policy implications of this paper are as follows: First, the nutrition status during the first 1000 days of life has long-lasting impacts on adult health and educational outcomes. The high rates of malnutrition in the early lives of children in various countries may imply that a large proportion of the children in these countries enter school with severe learning handicaps (Glewwe and King, 2001). Stunting early in a child’s life can cause irreversible damage to cognitive development and has educational, income, and productivity consequences that reach far into adulthood. The economic costs of undernutrition, in terms of lost national productivity and economic growth, are signifi-

cant—they range from 2 to 3% of GDP in various countries and up to 11% of GDP in Africa and Asia each year.⁸ The positive effect of nutrition assistance on child weight suggest that government subsidy programs that target poor households may be an effective approach for improving the health of human capital. Second, our gender-specific findings imply that nutrition subsidy alone may not necessarily improve the health of girls in the target group. Additional policy instruments, such as parental education, may enhance the policy impact. The supplier of the nutrition package may provide intensive public nutrition and gender equality education to caregivers in rural areas along with the distribution of complementary feeding. Efforts from the government, food entrepreneurs, and caregivers are needed to realize the effective use of nutrition supplementation to address health poverty.

Future studies can explore other aspects of parental nutrition investments in their children that we could not examine in this paper.⁹ One example is the category of child food expenditure. This information may provide additional evidence of the crowding out effect of public investment and private investment in child health. Moreover, this paper evaluates an intent-to-treat effect of nutrition supplementation. We cannot explore the individual take-up or estimate the treatment effect on the treated. Future studies can investigate the heterogeneity of individual take-up and estimate a treatment effect on the treated (TOT) using a large sample when information is available in the data set.

⁸World Bank, <https://www.worldbank.org/en/topic/nutrition/overview>

⁹The data from the China Health and Nutrition Survey contain more food and nutrition consumption variables. However, the most recent wave is 2015, which may not be sufficient for evaluating the policy that is being analyzed in the current study.

References

- Anderson, JW., Johnstone, BM., Remley, DT., 1999. Breastfeeding and cognitive development: A meta-analysis. *The American Journal of Clinical Nutrition* 70(4), 525-535.
- Bhutta, Z.A., Ahmed, T., Black, R.E., Cousens, S., Dewey, K., Giugliani, E., et al. (2008). What works? interventions for maternal and child undernutrition and survival. *Lancet* 371(9610), 417-440.
- Bruyeron, O., Khan, N., Berger, J., Salvignol, S., Monvois, C., Treche, S., 2007. Infant and young child feeding in Vietnam: 10 years of experience and lessons from the Fasevie project. Paris.
- Bleakley, H., 2007. Disease and development: evidence from hookworm eradication in the American South. *Q. J. Econ.* 122(1), 73-117.
- Bleakley, H., 2010. Malaria eradication in the Americas: a retrospective analysis of childhood exposure. *Am. Econ. J.: Appl. Econ.* 2, 1-45.
- Burke, V., Berlin LJ., Simmer, K., 2005. Breastfeeding and overweight: Longitudinal analysis in an Australian birth cohort. *The J of Pediatrics* 147(1), 56-61.
- Butte, N.F., 2001. The role of breastfeeding in obesity. *Pediatr. Clin. N. Am.* 48(1), 189-198. Burke, V., Beilin, L.J., Simmer, K., Oddy, W.H., Blake, K.V., Doherty, D., et al., 2005. Breastfeeding and overweight: longitudinal analysis in an Australian birth cohort. *J. Pediatr.* 147(1), 56-61.
- Cai, S., 2020. Migration under liquidity constraints: Evidence from randomized credit access in China. *J. Dev. Econ.* 142, 102247.
- Chakravarty, A., 2015. Gender-biased breastfeeding in Egypt: Examining the fertility preference hypotheses of Jayachandran and Kuziemko (2011). *J of Applied Econometrics* 30(5), 848-855.

- Chen, C., Wang, Y., He, W., Chang S., and Preedy V.R., 2013. In-home fortification of complementary feedings: Chinese perspectives. In: Preedy, V., Srirajaskanthan, R., Patel, V. (eds) Handbook of Food Fortification and Health.
- Chen, S., Li, S., Li, Y., Ma, Q., Xu, J., Liu, L., Chen, W., 2020. Relationship between 2-week prevalence of fever and diarrhea and Yingyangbao consumption among infants and young children impoverished area of Henan Province. *Wei Sheng Yan Jiu* 49(5) (in Chinese).
- Chen, Y., Li, H., 2009. Mother's education and child health: is there a nurturing effect? *J. Health Econ.* 28(2), 413-426.
- Chen, Y., Lei, X., and Zhou, L., 2017. Does raising family income cause better child health? Evidence from China. *Econ. Dev. Cult. Change* 65(3), 495-520.
- Cutler, D., Fung, W., Kremer, M., Singhal, M., Vogl, T., 2010. Early-life Malaria Exposure and Adult Outcomes: Evidence from Malaria Eradication in India. *Am. Econ. J.: Appl. Econ.* 2, 72-94.
- Demir, F., Ghosh, P., Liu, Z., 2020. Effects of motherhood timing, breastmilk substitutes and education in the duration of breastfeeding: Evidence from Egypt. *World Development* (133), 105014.
- Ebenstein, A., 2010. The 'missing girls' of China and the unintended consequences of the one child policy. *J. Human. Res* 45 (1), 87-115.
- Field, E., Robles, O., Torero, M., 2009. Iodine Deficiency and Schooling Attainment in Tanzania. *Am. Econ. J.: Appl. Econ.* 1(4), 140-69.
- Fahmida, U., Rumawas, J. S., Utomo, B., Patmonodewo, S., Schultink, W., 2007. Zinc-iron, but not zinc-alone supplementation, increased linear growth of stunted infants with low haemoglobin. *Asia Pac. J. Clin. Nutr.* 16(2), 301-309.
- Flegal, K. M., Tabak, C.J., Ogden, C.L., 2006. Overweight in children: definitions and interpretation. *Health Educ. Res.* 21(6), 755-760.

- Gdalevich, M., Mimouni, D., Mimouni, M., 2001. Breastfeeding and the risk of bronchial asthma in childhood: a systematic review with meta-analysis of prospective studies. *J. Pediatr.* 139(2), 261-266.
- Glewwe, P., Jacoby, H., King, E.M., 2001. Early childhood nutrition and academic achievement: a longitudinal analysis. *J. Public Econ.* 81(3), 345-368.
- Heinig, M.J., 2001. Host defense benefits of breastfeeding for the infant: effect of breastfeeding duration and exclusivity. *Pediatr. Clin. N. Am.* 48(1),105-123.
- Hoddinott, J., Maluccio, J.A., Behrman, J.R., Flores, R., Martorell, R., 2008. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *Lancet* 371(9610), 411-416.
- Hotz, C., Brown KH., editors. Assessment of the risk of zinc deficiency in populations and options for its control. *Food Nutr Bull* (25), 132S-62.
- Jayachandran, S., Kuziemko, I., 2011. Why do mothers breastfeed girls less than boys? Evidence and implications for child health in India. *Quarterly Journal of Economics* 126(3),1485-1538.
- Kleven, H., Landais, C., Sogaard, J. E., 2019. Children and gender inequality: Evidence from Denmark. *American Economic Journal: Applied Economics*, 11(4), 181-209.
- Kong, N., Osberg, L., Zhou W., 2019. The shattered “Iron Rice Bowl”: Intergenerational effects of Chinese State-Owned Enterprise reform. *J. Health Econ.* 67.
- Kuziemko, I., Pan, J., Shen, J., Washington, E., 2018. The mommy effect: Do women anticipate the employment effects of motherhood? NBER working paper no. 24740, available at <https://www.nber.org/papers/w24740> (accessed on November 24, 2020).
- Khadilkar, A., Das, G., Sayyad, M., Sanwalka, N., Bhandari, D., Khadilkar, V., et al., 2007. Low calcium intake and hypovitaminosis D in adolescent girls. *Arch Dis Child.* 92, 1045.

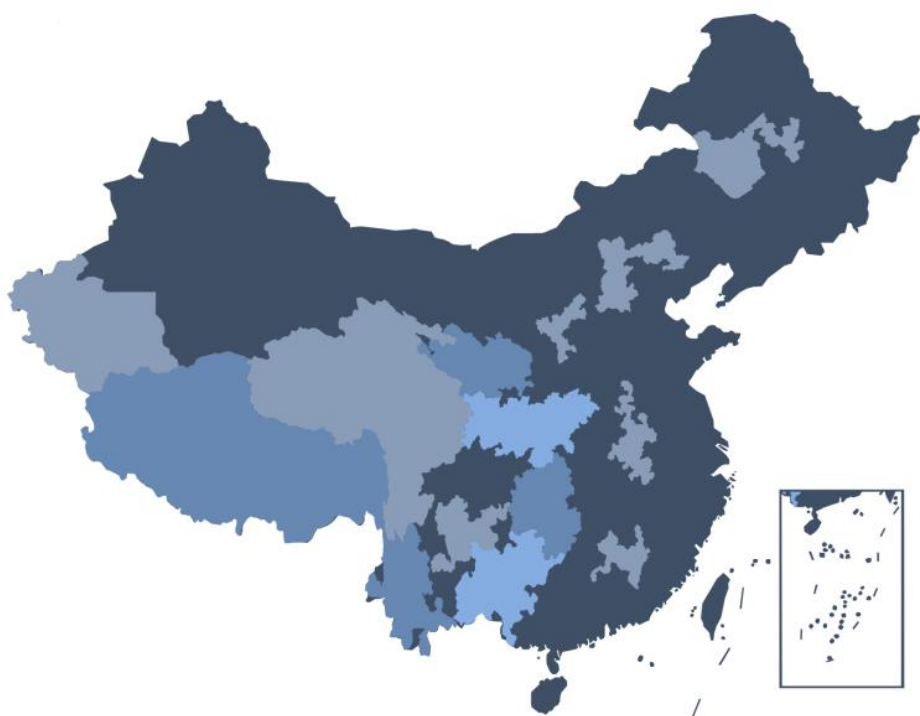
- Li, H., Yi, J., Zhang J., 2011. Estimating the effect of the one-child policy on the sex ratio imbalance in China: identification based on the difference-in-differences. *Demography* 48, 1535-1557.
- Li, Y., Zhang, X., Li, Y., Zhao, M., Zhao, L., Li., L., 2019, Vitamin D levels and influencing factors of infants aged 6-23 months in four poverty-stricken areas of Yunnan Province. *China J Dis Control Prev* 23(10), 1224-1229.
- Liu, H., Fang, H., Zhao, Z., 2013. Urban–rural disparities of child health and nutritional status in China from 1989 to 2006. IZA Discussion Papers 6528. Institute for the Study of Labor (IZA). Available at: <http://nbn-resolving.de/urn:nbn:de:101:1-2012081412543>
- Luo, R., Yue, A., Zhou, H., Shi, Y., Zhang, L., Martorell, R., et al., 2017. The effect of a micronutrient powder home fortification program on anemia and cognitive outcomes among young children in rural China: a cluster randomized trial. *BMC Public Health* 17(1).
- Luo, R., Shi Y., Zhou, H., Yue, A., Zhang, L., Sylvia, S., et al., 2015. Micronutrient deficiencies and developmental delays among infants: evidence from a cross-sectional survey in rural China. *BMJ Open* 5(10).
- Luo, R., Shi, Y., Zhou H., Yue, A., Zhang, L., Sylvia, S., et al., 2014. Anemia and feeding practices among infants in rural Shaanxi Province in China. *Nutrients* 6(12), 5975-5991.
- Lin, C., Sun Y., Xing C., 2018. Son Preference and Human Capital Investment among China’s Rural-Urban Migrant Households. IZA DP No. 11930. Available at: <https://www.iza.org/publications/dp/11930/son-preference-and-human-capital-inves> (access on September 21, 2020)
- Maluccio, J. A., John, H., Behrman, J. R., Reynaldo, M., Quisumbing, A. R., Stein, A. D., 2009. The impact of improving nutrition during early childhood on education among Guatemalan adults. *Econ. J.* 119, 734-763.

- Miguel, E., Kremer, M., 2004. Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. *Econometrica* 72(1), 159-217.
- Osei, AK., Houser, RF., Bulusu, S., Joshi, TP., 2010. Nutritional status of primary schoolchildren in Garhwali Himalayan villages of India. *Food Nutr Bull* (31), 221-233.
- Phu, P.V., Hoan, N.V., Salvignol, B., Treche, S., Wieringa, F.T., Khan, N.C., et al., 2010. Complementary foods fortified with micronutrients prevent iron deficiency and anemia in Vietnamese infants. *J. Nutr.* 140(12), 2241-2247.
- Sahu, M., Bhatia, V., Aggarwal, A., Rawat, V., Saxena, P., Pandey, A., et al., 2009. Vitamin D deficiency in rural girls and pregnant women despite abundant sunshine in northern India. *Clin. Endocrinol. (Oxf)* 70, 680-684.
- Schwarz, E.B., Ray, R.M., Stuebe, A.M., Allison, M.A., Ness, R.B., Freiberg, M.S., Cauley, J.A., 2009. Duration of lactation and risk factors for maternal cardiovascular disease. *Obstetrics and Gynecology* 113(5), 974-982.
- Sun, A., Zhang, C., Hu, X., 2019. Boys, girls, and grandparents: the impact of the sex of preschool-aged children on family living arrangements and maternal labor supply. *Demography* (56), 813-833.
- Strauss, J., Thomas, D., 1998. Health, nutrition, and economic development. *J. Econ. Lit.* 36(2), 766-817.
- Behrman, J. R., Rosenweig, M. R., 2002. Does increasing women's schooling raise the schooling of the next generation? *Am. Econ. Rev.* 92(1), 323-334.
- Van Hoan, N., Van Phu, P., Salvignol, B., Berger, J., Treche, S., 2009. Effect of the consumption of high energy dense and fortified gruels on energy and nutrient intakes of 6-10-month-old Vietnamese infants. *Appetite* 53(2), 233-240.
- Vilar-Compte, M, Teruel, G., Flores, D., García-Appendini, I., Ochoa-Lagunas, A., 2020. A longitudinal study of height gaps among Mexican children: Disparities

- and social inequity. *Social Science & Medicine* (264), 113388.
- Wei, Q.W., Zhang, J.X., Scherpbier, R.W., Zhao, C.X., Luo, S.S., Wang, X.L., Guo, S.F., 2015. High prevalence of developmental delay among children under three years of age in poverty-stricken areas of China, *Public Health* 129(12), 1610-1617.
- Wang, L., Gong, Z., Huo, J., Zhuo, Q., Shen, S., 2020. Effects of nutrition package on intestinal flora of infants by high-throughput sequencing. *Wei Sheng Yan Jiu* 49(2), 233-237 (in Chinese).
- Wang, Q., Wu, Y., Ye, R., Cai, M., Luo, R., Yue, A., Zhou, H., 2018, Factors analysis on caregivers' compliance behaviors in nutrition packages feeding by PRECEDE theory in poor rural areas of Southern Shaanxi Province. *J of Hygiene Research* 47(4), 599-604.
- Wang, Y., Monteiro, C., Popkin, B.M., 2002. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am. J. Clin. Nutr.* 75(6), 971-977.
- Walker, S.P., Wachs, T.D., Gardner, M.J., Lozoff, B., Wasserman G.A., Pollitt, E., et al., 2007. Child development: risk factors for adverse outcomes in developing countries. *Lancet* 369, 145-157.
- Jo, Y., Wang, Q., 2017. The impact of maternal employment on children's adiposity: Evidence from China's labor policy reform. *Health Economics* 26, e236-e255.
- Yue, A., Cai, J., Bai, Y., Tang, L., Shi, Y., Luo, R., and Rozelle, S., 2019. Challenges and possible solutions for children 0-3 years old in poor rural China. *J. East China Norm. Univ. (Educ. Sci. Ed.)* 3, 1-16 (in Chinese).
- Zhang, Q., Sun, J., Jia, X., and Huo, J., 2015. Meta analysis of the nutrition intervention effect of Yingyangbao on infants and young children in China. *Wei Sheng Yan Jiu* 44(6), 970-77 (in Chinese).

Zhang, C., Huang L., Ding, L., Liao, J., Xu, K., Xie, J., Yan, X., 2019. Prevalence of childhood nutritional diseases and effect of special dietary nutrition management in childcare institutions in zhongshan city. Guangxi Med. J. 41(14), 1763-1766 (in Chinese).

Figure 1: Contiguous areas of extreme poverty



Note: This figure shows the distribution of contiguous areas of extreme poverty. Source: China's Poverty Alleviation Database.

Table 1: Summary statistics of the variables

	Boys	Girls
Height-for-age z score	-2.076 (0.097)	-1.872 (0.097)
Weight-for-age z score	0.269 (0.048)	0.165 (0.044)
Stunting	0.409 (0.012)	0.391 (0.013)
Underweight	0.061 (0.006)	0.040*** (0.005)
Treatment intensity (unconditional)	0.071 (0.006)	0.083 (0.007)
Treatment intensity (conditional)	0.727 (0.025)	0.681 (0.026)
Age in months	45.259 (0.346)	44.563 (0.365)
Maternal education	2.797 (0.026)	2.711** (0.029)
Han	0.974 (0.004)	0.974 (0.004)
First birth	0.779 (0.010)	0.777 (0.011)
County GDP (log)	10.250 (0.015)	10.230 (0.016)
Financial index (log)	4.431 (0.010)	4.429 (0.010)
Birth rate	11.837 (0.033)	11.821 (0.036)
Health expenditure	1.810 (0.018)	1.795 (0.020)
Tertiary industry %	39.157 (0.134)	39.168 (0.148)
Year 2014	0.218 (0.010)	0.221 (0.011)
Year 2016	0.348 (0.011)	0.346 (0.013)
Year 2018	0.356 (0.012)	0.354 (0.013)
<i>N</i>	1718	1441

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ indicates that the difference in the variable between the boy and girl samples differs significantly from zero.

Table 2: Nutritional intake and the growth of boys

	HAZ	WAZ	Stunting	Under weight
Treatment intensity	-0.010 (0.463)	0.418* (0.221)	-0.008 (0.045)	-0.123** (0.059)
Age in months	0.032 (0.044)	0.005 (0.026)	-0.013** (0.006)	-0.001 (0.002)
Squared age/100	0.005 (0.047)	-0.014 (0.025)	0.009 (0.006)	0.001 (0.002)
Han	-1.030 (1.242)	0.240 (0.364)	0.078 (0.081)	0.007 (0.056)
First birth	0.446* (0.222)	-0.119 (0.087)	-0.056*** (0.017)	-0.034 (0.021)
Maternal education	0.474*** (0.102)	-0.067 (0.045)	-0.051*** (0.014)	0.005 (0.010)
County GDP (log)	0.363 (0.277)	0.134 (0.220)	-0.034 (0.051)	-0.025* (0.013)
Financial index (log)	-0.487 (0.504)	-0.387 (0.398)	-0.011 (0.067)	0.019 (0.062)
Birth rate	-0.108 (0.175)	-0.073 (0.096)	0.020 (0.018)	-0.001 (0.009)
Health expenditure	0.465 (0.664)	-0.258 (0.639)	-0.095 (0.060)	0.021 (0.033)
Tertiary industry %	0.031 (0.040)	0.010 (0.040)	-0.001 (0.005)	-0.002 (0.003)
Constant	-6.533 (4.553)	1.483 (2.422)	1.331* (0.717)	0.420 (0.410)
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.272	0.097	0.245	0.180
N	1718	1718	1718	1718

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old boys who were born between 2010 and 2016 in rural counties. Standard errors that are clustered at the provincial level are specified in parentheses.

Table 3: Nutritional intake and the growth of girls

	HAZ	WAZ	Stunting	Under weight
Treatment intensity	-0.570 (0.584)	-0.235 (0.274)	0.111 (0.087)	0.031 (0.033)
Age in months	-0.026 (0.050)	-0.003 (0.012)	-0.007 (0.008)	0.001 (0.002)
Squared age/100	0.025 (0.050)	-0.007 (0.013)	0.008 (0.008)	-0.001 (0.002)
Han	0.103 (1.558)	0.517* (0.262)	-0.055 (0.104)	-0.148** (0.064)
First birth	-0.043 (0.245)	-0.219 (0.163)	0.003 (0.041)	0.022 (0.020)
Maternal education	0.150 (0.110)	0.050 (0.072)	-0.028* (0.016)	-0.001 (0.006)
County GDP (log)	0.603** (0.275)	0.505*** (0.141)	-0.081 (0.051)	-0.039* (0.019)
Financial index (log)	0.313 (0.555)	-0.001 (0.301)	-0.049 (0.069)	0.055 (0.063)
Birth rate	-0.474*** (0.158)	-0.222 (0.147)	0.062** (0.029)	-0.006 (0.011)
Health expenditure	-0.321 (0.618)	0.130 (0.500)	0.038 (0.047)	-0.012 (0.030)
Tertiary industry %	-0.014 (0.044)	0.003 (0.039)	0.003 (0.006)	-0.003* (0.002)
Constant	-4.004 (5.132)	-2.751 (2.795)	0.954 (0.752)	0.469 (0.541)
R ²	0.235	0.164	0.206	0.145
N	1441	1441	1441	1441
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.239	0.164	0.209	0.146
N	1441	1441	1441	1441

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old girls who were born between 2010 and 2016 in rural counties. Standard errors that are clustered at the provincial level are specified in parentheses.

Table 4: Exploring the policy intensity category

	HAZ	WAZ	Stunting	Under-weight
Panel A: boys				
High intensity	0.159 (0.513)	0.506** (0.227)	-0.031 (0.042)	-0.111* (0.058)
Low intensity	-0.039 (0.363)	0.200 (0.214)	-0.054 (0.068)	-0.070** (0.032)
R ²	0.272	0.097	0.246	0.180
N	1718	1718	1718	1718
Panel B: girls				
High intensity	-0.396 (0.732)	-0.360 (0.350)	0.117 (0.112)	0.038 (0.032)
Low intensity	0.699 (1.345)	0.015 (0.214)	-0.010 (0.154)	0.001 (0.036)
R ²	0.237	0.165	0.207	0.146
N	1441	1441	1441	1441
Control variable	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old children who were born between 2010 and 2016 in rural counties. Standard errors are clustered at the provincial level. High (low) intensity indicates that a child receives the nutrition package for a longer (shorter) duration than the conditional mean.

Table 5: Effects of nutritional intake on growth: Other standards

	Chinese standard		CDC standard	
	HAZ	WAZ	Stunting	Under-weight
Panel A: boys				
Treatment intensity	0.005 (0.079)	0.185 (0.118)	0.004 (0.009)	-0.137* (0.067)
R ²	0.267	0.074	0.078	0.158
N	1718	1718	1718	1718
Panel B: girls				
Treatment intensity	-0.831 (0.846)	-0.251 (0.224)	0.089 (0.137)	0.022 (0.032)
R ²	0.242	0.157	0.330	0.126
N	1441	1441	1441	1441
Control variable	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first two columns use mean and standard deviation values that were calculated from the CFPS sample. The last two columns define the statuses of being stunted and underweight according to CDC standard. The sample includes 2-to-6-year-old children who were born between 2010 and 2016 in rural counties. Standard errors are clustered at the provincial level.

Table 6: Effects of nutritional intake on the growth of boys:
Robustness evaluation

	HAZ	WAZ	Stunting	Under-weight
Panel A: Restricted sample of poor counties				
Treatment intensity	-0.266 (0.657)	0.451* (0.235)	0.013 (0.061)	-0.131*** (0.041)
R ²	0.292	0.094	0.248	0.195
N	626	626	626	626
Panel B: Addition of province-by-year fixed effects				
Treatment intensity	-0.351 (0.439)	0.390** (0.179)	0.040 (0.042)	-0.105* (0.058)
R ²	0.296	0.150	0.271	0.208
N	1718	1718	1718	1718
Control variable	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old children who were born between 2010 and 2016 in national poor rural counties in Panel A. The sample includes 2-to-6-year-old children who were born between 2010 and 2016 in rural counties in Panel B. Standard errors are clustered at the provincial level.

Table 7: Falsification test: Exploring variations in the control group and urban area

	HAZ	WAZ	Stunting	Under-weight
Panel A: Exploring heterogeneity in the control group				
Pseudo treatment	-0.238 (0.336)	0.310 (0.271)	-0.058 (0.038)	0.015 (0.013)
Control variable	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.241	0.114	0.220	0.172
N	1387	1387	1387	1387
Panel B: Exploring the urban area				
Pseudo treatment	-1.116 (1.293)	-1.107 (0.834)	0.050 (0.112)	0.126 (0.074)
Control variable	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.309	0.259	0.286	0.180
N	912	912	912	912

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In Panel A, the sample includes 2-to-6-year-old children in rural counties excluding those who are covered by the nutrition program. Pseudo treatment is defined by the interaction of poor county (dummy) and birth cohort after 2014 (dummy). In Panel B, the sample includes 2-to-6-year-old children in urban neighborhoods. Pseudo treatment is equivalent to the “treatment intensity” variable in Model 1, namely, we assume the nutrition program covers both rural counties and urban areas in the same city.

Table 8: Heterogeneous effect of policy on the maternal education category

	HAZ	WAZ	Stunting	Under-weight
Panel A: Maternal education above junior high				
Treatment intensity	0.909 (0.616)	0.343 (0.484)	-0.049 (0.068)	-0.110 (0.082)
R ²	0.247	0.158	0.240	0.259
N	1112	1112	1112	1112
Panel B: Maternal education junior high or below				
Treatment intensity	-0.630 (0.737)	0.240 (0.155)	-0.084 (0.104)	-0.152*** (0.042)
R ²	0.323	0.165	0.321	0.190
N	606	606	606	606
Control variable	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old boys who were born between 2010 and 2016 in rural counties. Standard errors are clustered at the provincial level.

Table 9: Breastfeeding and nutrition supplementation: substitutes or complements

	Breastfeeding (month in log)			
	Rural county		Poor county	
	Boys	Girls	Boys	Girls
Treatment intensity	0.208*	-0.059	0.283**	-0.168**
	(0.104)	(0.077)	(0.121)	(0.075)
Control variable	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.173	0.173	0.119	0.150
N	1718	1441	626	563

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The sample includes 2-to-6-year-old children in rural counties. Breastfeeding is measured by the months of breastfeeding a child has received.

Table Appendix 1: Ingredients of a daily nutrition package (12g)

Nutrient	Unit	Content per pack
Protein	g	≥ 3
Calcium	mg	200
Iron	mg	7.5
Zinc	mg	3.0
Folic acid	μg	75
Vitamin A	μg	250
Vitamin D	μg	5
Vitamin B1	mg	0.5
Vitamin B2	mg	0.5
Vitamin B12	μg	0.5

Notes: National Health Commission (2014).