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Research Article

# The Effect of Income on Child Nutrition in China

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**Abstract:** This study examines the determinants of child nutritional status in China, focusing specially on the household income effect. Data are drawn from China Health and Nutrition Survey, including 4 waves from 1991 to 2000. The empirical relationship between nutritional status and income, on the one hand and other effect factors like mother's height, maternal education, location (urban vs. rural, north vs. south) is investigated. Ordinary Least Squares, Random Effects, Fixed Effects and Instrumental Variables models are used, respectively. In the preferred model, a fixed effects model where income is instrumented, we find that the household income per capita shows no significant impact on the height-for-age z-scores.

**Keywords:** Child, China, effect, income, nutrition

## INTRODUCTION

During the period 1990s, there was a remarkable fall in the national prevalence of child undernourished in China. Also there are significant differences in malnutrition among urban and rural children and between different provinces (Chang *et al*., 1996). This large scaled child undernourishment seems to be inconsistent with the high economic growth rate in China ever since 1990, since income has been found to be positive and significant in 72% of studies about child nutrition (Charmarbagwala *et al*., 2004). Beside income, in explaining undernourishment, it is usually observed that child nutritional status is the outcome of a complex interaction of other determinants. Mother's height is found to be an important determinant of a child's growth (Xu *et al*., 1995; Blumenfeld *et al*., 2006). As in analyses of developing countries (Glewwe, 1999; Handa, 1999), maternal education was also showed to produce positive effect on child nutrition. Objective of the study is to shed some light on the determinants of child nutritional status in China in the 1990s, with a special focus on the role of income. The study starts with a description of the data, followed by an explanation of the model specification. Then, the empirical relationships are explored using Ordinary Least Squares (OLS) (Greene, 1981), Random Effects (RE) (Laird and Ware, 1982), Fixed Effects (FE) (Bhargava *et al*., 1982) and Instrumental Variables (IV) (Scoggins, 2001; Chamberlain, 2007) models.

## MATERIALS

Data are drawn from a large-scale panel survey, the China Health and Nutritional Survey (CHNS) (Tudor-Locke *et al*., 2003). A random cluster procedure was used to draw the sample. Four waves from 1991 through 2000 and 7 provinces of Shandong, Henan, Jiangsu, Hubei, Hunan, Guangxi and Guizhou are included. The sample is restricted to children under the age of 15 in order to attempt the measurement errors associated with variation in the adolescent growth spurt.

There were 306 individuals in each wave, divided by 270 households and 166 communities. The total observation is 1224. Descriptive statistics are shown in Table 1. Dependent variable is the height-for-age z-score. It is a dimensionless quantity derived by subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation. The 95% prediction interval is from 2 to Sample mean of z-score is 1.073 (Table 1), a little bit lower than the average 0, but still falls into the normal interval. The measure of income used is the log of gross household income per capita; with the unit Chinese Yuan (CNY). Other variables relevant to the child nutritional status are included in the model as covariates. Dummy variables such as male, urban, leaving in northern part of China or not, whether have a health insurance, equals to 1 if the answer is yes. Mother education is categorized into 4 levels, no school, primary school, middle school, high school or more. No school is used as a reference. Mother's height, measured in centimeters and mother's weight, measured in kilogram, are included to capture the child's unobserved growth potential or genetic endowment. In particular, each observation with missing value is assigned a value equivalent to the mean of the values of all other observations in the cluster or community. See the formula:

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Table 1: Descriptive statistics, disaggregated by survey wave

| | All | | 1991 | | 1993 | | 1997 | | 2000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| **Variables** | | | | | | | | | | |
| Height-for-age z-score | -1.0740 | 1.5500 | -1.0890 | 2.1620 | -1.2670 | 1.4190 | -1.0630 | 1.2290 | -0.8750 | 1.1660 |
| Log household income per capita (Yuan) | 7.0370 | 1.0700 | 6.4650 | 0.9550 | 6.7550 | 1.0020 | 7.4010 | 0.9460 | 7.5270 | 0.9990 |
| Sex (male = 1) | 0.5520 | 0.4970 | 0.5520 | 0.4980 | 0.5520 | 0.4980 | 0.5520 | 0.4980 | 0.5520 | 0.4980 |
| Age (years) | 7.7660 | 3.8550 | 3.4960 | 1.6110 | 5.5100 | 1.6070 | 9.5340 | 1.6010 | 12.525 | 1.6110 |
| Age squared | 75.162 | 62.764 | 14.810 | 10.913 | 32.935 | 17.182 | 93.446 | 29.918 | 159.459 | 39.733 |
| Urban (urban = 1) | 0.2420 | 0.4280 | 0.2420 | 0.4290 | 0.2420 | 0.4290 | 0.2420 | 0.4290 | 0.2420 | 0.4290 |
| North (North = 1) | 0.3760 | 0.4850 | 0.3760 | 0.4850 | 0.3760 | 0.4850 | 0.3760 | 0.4850 | 0.3760 | 0.4850 |
| Health insurance (yes = 1) | 0.2320 | 0.5960 | 0.2420 | 0.4290 | 0.2780 | 0.9540 | 0.1960 | 0.3980 | 0.2120 | 0.4100 |
| **Maternal education** | | | | | | | | | | |
| Primary | 0.2030 | 0.4030 | 0.1930 | 0.3950 | 0.2060 | 0.4050 | 0.1900 | 0.3930 | 0.2250 | 0.4190 |
| Middle | 0.3180 | 0.4660 | 0.3170 | 0.4660 | 0.3140 | 0.4650 | 0.3240 | 0.4690 | 0.3170 | 0.4660 |
| High | 0.1410 | 0.3480 | 0.1340 | 0.3410 | 0.1340 | 0.3410 | 0.1410 | 0.3480 | 0.1540 | 0.3610 |
| Mother's height (cm) | 154.646 | 5.6010 | 154.646 | 5.6080 | 154.646 | 5.6080 | 154.646 | 5.6080 | 154.646 | 5.6080 |
| Mother's weight (kg) | 52.913 | 7.5220 | 51.515 | 7.2200 | 51.862 | 6.7340 | 53.389 | 7.5130 | 54.885 | 8.1100 |
| **Instruments** | | | | | | | | | | |
| Household size | 4.6720 | 1.3620 | 4.7480 | 1.4950 | 4.7780 | 1.4410 | 4.6270 | 1.2670 | 4.5360 | 1.2180 |
| Log value of house | 9.1860 | 1.2970 | 8.9850 | 1.1820 | 9.0160 | 1.1700 | 9.3140 | 1.2720 | 9.4280 | 1.4890 |

~~Robust standard errors clustered at the community level were used;~~ China Health and Nutrition Survey (1991-2000)~~; Significant codes: 00.01 0.05 V 0.1~~

$$\sum_{i=1}^{n}\frac{Y_n+Y_i}{n-1} \tag{1}$$

where,

$i$ : Observation i with missing value

$n$ : Number of the observations in the community

## MATHODOLOGY

The nutritional status of child i at time t, can be modeled as a function of household income, a set of child-specific characteristics ($\gamma X_{it}$), such as age, gender, health insurance, and a set of maternal characteristics ($\psi W_{it}$), such as maternal education, mother's height and weight, as well as the location dummies such as urban and north China:

$$H_{it} = \alpha + \beta_1 \text{income}_{it} + \gamma X_{it} + \psi W_{it} + \sigma_1\, 1993 + \sigma_2\, 1997 + \sigma_3 2000 + \mu_i + \varepsilon_{it} \tag{2}$$

In particular, year dummies ($\sigma_1\, 1993$, $\sigma_2\, 1997$ and $\sigma_3 2000$) are also included in the model in order to capture the survey wave. Year dummies may control the time effects that have the same influence on the nutritional status of all children. Firstly, pooled OLS model is the foundation of this analysis. Since observations within community clusters are likely to be serial correlated, community-clustered robust standard errors are used to avoid over or underestimating the true standard errors. Second, a Random Effect (RE) model is estimated, which is a more efficient estimator than the above pooled OLS model. Third, since unobserved time-invariant factors ($\mu_i$) may be correlated with some of the explanatory variables, a Fixed Effect (FE) model is estimated. An example of such an unobserved factor could be the general level of economic development of the community (compared with other communities) which could exert a direct effect on nutritional status, and also be correlated with household income.

To get an accurate specification test between RE and FE, the Hausman test (Hausman *et al*., 2005) is done ($\text{chi}^2(8) = 39.12$) and confirms that the FE model performs better than RE.

Fourth, since income, the key explanatory variable, is potentially endogenous, an instrument variables approach to the OLS and FE model is explored. For example, the establishment of an environmentally harmful factory may increase the households' income but also cause a negative effect on child health. Failure to control for this simultaneity will generate biased estimates of income, and also affect other covariates that are correlated with income.

## RESULTS

**Findings of OLS, RE and FE models:** The household income is positive and highly significant at the 1% level in the pooled OLS model (Table 2). However, in RE, the significant level decreases to 10% level and the coefficient falls from 0.139 to 0.072 (Table 2). Furthermore, although significant in the OLS and RE models, the income variable becomes insignificant once fixed effects are controlled for (Table 2). This FE model will be further explored in the next section, where income is instrumented. North is found to be one of the most important predictors of nutritional status: control

Table 2: Regression of height-for-age z-scores in pooled OLS, RE, FE and IV models

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| | Full OLS | RE | FE | IV OLS | IV FE |
| Log household income per capita (Yuan) | 0.139 (0.05)*** | 0.072 (0.04)* | 0.004 (0.05) | 0.920 (0.34)*** | -0.274 (0.66) |
| Sex (male = 1) | 0.121 (0.11) | 0.125 (0.11) | (omitted) | 0.153 (0.11) | (omitted) |
| Age (years) | -0.516 (0.11)*** | -0.483 (0.11)*** | -1.528 (0.56)*** | -0.473 (0.12)*** | -1.417 (0.66)** |
| Age squared | 0.027 (0.01)*** | 0.024 (0.00)*** | 0.023 (0.00)*** | 0.024 (0.01)*** | 0.024 (0.00)*** |
| Urban (urban = 1) | 0.117 (0.13) | 0.189 (0.13) | (omitted) | -0.249 (0.20) | (omitted) |
| North (North = 1) | 0.357 (0.15)** | 0.377 (0.15)** | (omitted) | 0.374 (0.16)** | (omitted) |
| Health insurance (yes = 1) | 0.117 (0.09) | 0.064 (0.07) | 0.019 (0.06) | 0.102 (0.13) | 0.002 (0.08) |
| **Maternal education** | | | | | |
| Primary | -0.167 (0.19) | -0.104 (0.18) | 0.13 (0.28) | -0.348 (0.22) | 0.167 (0.23) |
| Middle | 0.022 (0.15) | -0.074 (0.13) | -0.536 (0.23)** | -0.312 (0.19)* | -0.552 (0.20)*** |
| High | 0.13 (0.19) | 0.125 (0.17) | 0.021 (0.20) | -0.228 (0.24) | 0.173 (0.55) |
| Mother's height (cm) | 0.034 (0.01)** | 0.038 (0.01)*** | (omitted) | 0.017 (0.02) | (omitted) |
| Mother's weight (kg) | 0.023 (0.01)** | 0.021 (0.01)*** | 0.018 (0.01) | 0.023 (0.01)*** | 0.013 (0.02) |
| Year dummies | | | | | |
| 1993 | 0.328 (0.11)*** | 0.329 (0.11)*** | 2.479 (1.14)** | 0.066 (0.19) | 2.319 (1.29)* |
| 1997 | 0.875 (0.27)*** | 0.944 (0.27)*** | 7.445 (3.33)** | 0.103 (0.48) | 6.959 (3.85)* |
| 2000 | 0.795 (0.34)** | 0.948 (0.34)*** | 10.678 (4.96)** | -0.014 (0.53) | 9.830 (5.84)* |
| Constant | -7.327 (2.03)*** | -7.394 (2.05)*** | 3.126 (2.02) | -9.615 (2.33)*** | 4.75 (4.42) |
| Observations = 1224 | | | | | |

Robust standard errors clustered at the community level in parentheses: 166 community fixed effects; China Health and Nutrition Survey (1991-2000); *: Significant at 10%; **: Significant at 5%; ***: Significant at 1%

Table 3: Regression of log household income on the IV variables and other covariates

| Variables | Coefficients | S.D. |
|---|---|---|
| Household size | -0.084*** | 0.025 |
| Log value of house | 0.117*** | 0.028 |
| Sex (male = 1) | -0.065 | 0.065 |
| Age (years) | -0.067** | 0.032 |
| Age squared | 0.004** | 0.002 |
| Urban (urban = 1) | 0.411*** | 0.114 |
| North (North = 1) | -0.084 | 0.106 |
| Health insurance (yes = 1) | -0.009 | 0.089 |
| Maternal education | | |
| Primary | 0.166 | 0.107 |
| Middle | 0.315*** | 0.089 |
| High | 0.386*** | 0.106 |
| Mother's height (cm) | 0.021*** | 0.008 |
| Mother's weight (kg) | -0.002 | 0.007 |
| Year dummies | | |
| 1993 | 0.356*** | 0.095 |
| 1997 | 0.995*** | 0.164 |
| 2000 | 1.045*** | 0.236 |
| Constant | 2.680** | 1.047 |
| $R^2 = 30.25\%$ | | |

Robust standard errors clustered at the community level were used; China Health and Nutrition Survey (1991-2000); *: Significant at 10%; **: Significant at 5%; ***: Significant at 1%

ling for other factors, children from North China have height for age scores that are greater than children from South China. This result is easy to explain, as people's body sizes in North China are larger than South China on the whole.

The positive coefficients on all three of the time dummies provide clear evidence that the nutritional status of children in China is secularly improved from 1991 to 2000. For the coefficients of most of the other variables, in all models, the magnitude and direction confirm to our expectations. Mother's height and weight are indeed found to be important on child's growth, either because of the genetic factor or because of their effect on children's birth weight. Height-for-age z-scores drop significantly as children get older, but at a decreasing rate, indicating substantial age-related growth failure. Finally, urban shows no significant impact on nutrition. One possible explanation for that is rural children tend to have worse access of health care, but better food resource and environment in the countryside, which can make a balance between the positive and negative effect.

**Findings of IV OLS and IV FE models:** The income variable is suspected to be endogenous with $\varepsilon_{it}$, not just $\mu_i$, as mentioned in the above section. To address this problem, an instrumental variable technique is explored. Two instruments- price of the house (measured in Chinese Yuan with the formula log) and the number of people in household. These instruments satisfy the three conditions:

- Be individually significant ($F\ (16{,}115)\ =\ 25.30$) and explain a sufficient share of the variation in income ($R^2\ =\ 30.25\%$) in the first stage.
- Be validly excluded from the main equation. Regressions of the residuals from the main equation on the instruments and other covariates did not yield significant coefficients on the instruments, suggesting that the instruments are excluded from the main Equation.
- Be uncorrelated with the error term. The Hansen test of over identification could not be rejected ($p > cai^2\ =\ 0.188$).

Regression results are shown in Table 3. The preferred FE model does not yield a significant coefficient on the income variable (Table 2). This result is surprisingly not consistent with the common view and previous study. However, it should not be interpreted as evidence that income does not affect nutritional status or that policies aimed at improving household incomes are not effective in improving child nutritional status. As mentioned in the previous section, the differences of community income level may be absorbed as the unobserved factor in $u_i$, which has a positive impact on nutrition status. Therefore, one reasonable explanation for the difference results in RE and FE is that, the relationship between income and nutritional status observed in the initial OLS and RE models is attributable to variation in income between communities rather than between households. All the estimates showed an insignificant effect of health insurance and mothers with middle school education level have worse nourished children than those with no schooling. This result will be better explained if the relationship of mother's job type and education level are explored, since job type determines whether mother has necessary knowledge and enough time to take care of the children. In the IV OLS models, the income coefficient is significant, which is consistent with the previous study (Table 2). In a meta-analysis, Haddad *et al*. (2003) find that OLS estimates of income on nutritional status have ranged from 0.075 to 0.287 and IV OLS estimates have ranged from 0.081 to 0.815.

## CONCLUSION

Although household income shows no direct effect on nutrition, greater incomes mean that families can invest more in food consumption, access to clean water and effective health care. Thus household income may affect the child nutrition indirectly. Income is found to be significant in the OLS and RE models where the community fixed effects are not controlled. At the community level, greater community average income will eventually lead to a better access to and better quality of health care centers and water and sanitation systems. So policies aimed at improving the community incomes in general are suggested to implement, especially in rural areas. Also, more resources available to a household should translate into higher expenditures on food and health care.

## LIMITATIONS

First, people with too high or too low household income are unwilling to answer the survey, which are recorded as missing data and replaced with an average income in the community. However, this kind of technique may cause results in biased estimates. A censored model is considered to be a better method in the further study. Second, the use of instrumental variables can create its own problems. The fit of the incrementing regression is not so good, so that the poorly predicted variable may incorrectly be found insignificant in the 2nd step estimation. Household size is used as an instrument in the model. However, it may not explain income so well. If household is large because it comprises a large number of people of working age, then this may cause a higher household per capita and a better child nutrition status. But if there are many young children competing for resources, then the effect of household size will be negative. So compared with household size, the dependency ratio (ratio of non-working to working household members) is a better choice as an instrument variable. However, the ratio data are not included in the data base.

Thirdly, there are other variables which may have impact on child nutrition. Type of parent's job gender of the household head and water quality in the community are found to be significant in the survey (Charmarbagwala *et al*., 2004). Omitted of these main variables may cause a bias in the estimation analysis.

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