Do spikes in food prices increase the risk of malnutrition among children? A quasi-natural experiment using longitudinal data in Andhra Pradesh, India

Sukumar Vellakkal, PhD[1,3], Jasmine Fledderjohann, PhD[1], Sanjay Basu, PhD[2], Sutapa Agrawal, PhD[3], Shah Ebrahim, DM[4], Oona Campbell, PhD[4], Pat Doyle, PhD[4], David Stuckler, PhD[1,3]

1 – Department of Sociology, University of Oxford

2 – Department of Medicine, Stanford University

3 – Public Health Foundation of India

4 – Department of Non-Communicable Disease Epidemiology, London School of Hygiene & Tropical Medicine

Corresponding author: Sukumar Vellakkal, PhD. Email <sukumar.vellakkal@phfi.org>
Phone: 0044-7459513432

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Abstract

Background Global food prices rose sharply since 2007. We investigated the effect of food price rises on child nutrition in Andhra Pradesh, India.

Methods A quasi-natural experiment design was employed based on periods prior to (2006) and after (2009) food price spikes, using the Young Lives longitudinal cohort of 1,922 children and the food price data from National Sample Survey Office. Two-stage instrumental variables least-squares models assessed the relation of food prices changes to food consumption and wasting prevalence (weight-for-height z-scores).

Findings Prior to when food prices were rising, wasting prevalence fell from 19.4% in 2002 to 18.8% in 2006. Coinciding with India's escalating food prices, wasting increased significantly to 28.0% in 2009. These prevalence increases were concentrated among low- (χ^2 (1) = 21.6, p <0.001) and middle-income groups (χ^2 (1) = 25.9, p <0.001) but not among high-income groups (χ^2 (1) = 3.08, p = 0.079). Each 10 rupee increase (US$0.17) in the price of rice/kg was associated with 148 grams/day drop in rice consumption (β = -14.8, 95% CI: -21.6 to -8.1). Correspondingly, lower rice consumption was significantly associated with lower weight-for-height Z scores (i.e., wasting) by 0.23 (95% CI: 0.04 to 0.43), as seen with most other food categories. These adverse associations were disproportionately greater in low- and middle-income households.

Interpretation Rising food prices have adversely affected children's risk of wasting in India. Policies to help ensure the affordability of food in the context of economic growth are likely critical for promoting children's nutrition.

Introduction

Although India has experienced remarkable economic growth since 2000,[1] the nation's progress in reducing malnutrition has stagnated.[2-4] Globally about one third of all malnourished children live in India. According to the latest round of the National Family Health Survey for the years 2005-2006, approximately 16% of Indian children were wasted and 50% were underweight.[5]

One potential reason that India's nutritional progress has failed to keep pace with economic development is because the nation's food prices have risen markedly in recent years. Worldwide, food prices rose sharply in the aftermath of the 2007 financial crisis.[6] The Food and Agriculture Organization's Global Food Price Index jumped from 134.7 in January 2007 to 225.8 in June 2008,[7] as prices of bananas rose 31%, wheat 77%, and rice 166%.[8] Ecological projections suggest that these price rises would tip an additional 75 million people into extreme hunger with likely adverse effect on maternal and child nutrition, the majority whom live in India.[9-13] However, these estimates were critiqued as "made up numbers" because they were based on extrapolated relationships of the impact of food prices on consumption. These forecasts also did not capture whether global prices actually transmit to India, nor whether households would be able to allocate scarce food resources to vulnerable children so as to stabilise their nutritional intake in the context of increasing unaffordability of food.[14] It is also not known whether a rise in food prices would affect the entire population or have a concentrated adverse impact on deprived households.

Testing the impact of food price spikes on Indian's children's nutrition is challenging, in part because of the lack of available longitudinal data that link children's food consumption to market environments. Our initial review of the Indian National Sample Survey Office's (NSSO) monthly Rural Price Dataset reveals that domestic food prices did increase in association with global rises in food commodity prices, albeit less markedly, between 2006 and 2009.[15] Figure 1 shows that real domestic Indian food prices rose slightly between 2002 and 2006, then increased sharply. Between 2006 and 2009 real prices increased in milk (21.6%), meat (23.8%), rice (36.8%), vegetables (56.5%), pulses (70.0%), and eggs (81.2%).

[Figure 1 about here]

In this study, to our knowledge for the first time, we test the hypothesis that these escalating prices of rice, pulses, eggs, and other staples of Indian diets significantly increased children's risk of wasting by linking these food price data with longitudinal data on children's food consumption and nutritional outcomes from the Young Lives India dataset. The Young Lives dataset is a unique dataset in that it tracks children over time from birth through to age 8 years. Two-stage least square models were used to test the joint hypotheses that the rising food prices reduced children's food consumption and as a result increased their risks of wasting.

Data and Methods

Study Settings

We used data covering periods before and after food price rises in the state of Andhra Pradesh, one of India's largest states with more than 85 million people.[16]

Measuring Children's Food Consumption and Wasting

Data on children's food consumption and nutrition were taken from the Young Lives Study. Young Lives is a longitudinal cohort study set up in 7 districts of Andhra Pradesh in 2002 (wave 1) which included 2000 children aged 6-18 months, followed up at about 5 years of age in 2006 (wave 2) and again at 8 years of age in 2009 (wave 3). Sampling details of the Young Lives Study have been described elsewhere. [17,18] Briefly, representative data were collected for all socioeconomic groups, drawing from the three major geographic locations in

Andhra Pradesh (Seemandhra, Telengana, and Rayalaseema), each including a developed site and non-developed site. The survey collected information on a wide range of household, policy, and child poverty-related variables from caregivers. Attrition rates and missing data were low: 4% of the samples were lost to follow-up and an additional 8 cases lacked nutrition measures, yielding a final analytical sample of n = 1,922 children.

Food intake was measured based on daily food expenditure and quantity of intake from caretaker's (usually mother's) report obtained through personal interview. Food items were aggregated into 8 major consumption categories: rice, wheat, pulses (including dried peas, edible beans, lentils, chickpeas, etc.), meat (including chicken, goat, and lamb), fish, eggs, milk, fruit, and vegetables. Since rice plays a particularly prominent role in Indian diets, where the share of energy intake contributed by cereals was about 60% for rural India and about 50% for urban India in 2009-10,[19] the interpretation of results focuses largely on changing rice prices and consumption, in addition to other major dietary staples.

Following the WHO methodology, Young Lives calculated children's nutrition outcomes using standardised z-score measures that compares children's weight, height, and age to the WHO reference population, including wasting (weight-for-height) which is susceptible to short-term fluctuations and, as a control condition, stunting (height-for-age) since height should not change rapidly in response to a food price spike.[18,20] These z-scores have the same statistical relation to the distribution of the reference around the mean at all ages, which makes results comparable across ages groups and populations.[20] Wasting (thinness) is a strong predictor of infant mortality, indicating in most cases a recent and severe process of weight loss that is often associated with acute food shortage.[5,20] To maximise statistical power, we evaluated z-scores rather than a dichotomous indicator of wasting, although results were replicated and were similar using a dummy variable for whether children were wasted (i.e., weight-for-age <-2 standard deviations).

Measuring Food Prices

Food price data were taken from the NSSO monthly price records collected by the Government of India, covering 132 food commodities from 603 village-market hubs spread over 24 major Indian states. District level food price data from the 7 districts of Andhra Pradesh were included in Young Lives. Prices were aggregated to match the 8 major food groups included in the Young Lives survey. To correct for non-food price inflation, so measuring purchasing power, we adjusted the data using the government approved non-food consumer price index.

Statistical analysis

Two-stage least squares models were used to assess firstly, the effect of changes in food prices on food consumption, and then to examine the relation of these consumption changes which were specifically attributable to food prices rises to children's nutritional risk (a so-called 'instrumental variables' approach). This instrumental variable approach substantially reduces potential confounding because any unobserved endogenous factors would need to be associated with both food prices and food consumption, which is unlikely as there were no major natural events during this period (such as droughts or floods) in Andhra Pradesh. Nonetheless, to further adjust for potentially confounding socio-demographic factors, we corrected models for the effects of children's age, sex, rural-urban residence, mother's education, as follows:

Equation 1. $\Delta Consumption_{i,} = \alpha + \beta_1 \Delta Price_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 HHsize_i + \beta_5 Urban_i + \beta_6 Education_i + \beta_7 Wealth_i$

Equation 2. $\Delta Nutrition_{i,} = \alpha + \beta_1 \Delta Consumption_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 HHsize_i + \beta_5 Urban_i + \beta_6 Education_i + \beta_7 Wealth_i$

Here *i* is child. Δ is difference in value in 2009 compared with the year 2006. Consumption is a vector of percapita daily food consumption; Nutrition is children's weight-for-height (wasting); Price is a vector of food prices for each of the 8 food items; HHsize is the household size; Urban is a dummy for the household's urban or rural location; Education is the mother's educational years; Wealth is a categorical variable of three evenly divided income groups (low, middle and high income). All models were performed using STATA ver13.1.[21]

Results

Rising Food Prices and Nutrition in India

Table 1 provides descriptive statistics for the analytical sample. Fifty-three percent of children were male. The mean age was 12.3 months in wave 1, 64.8 months in wave 2 and 96.0 in wave 3.

[Table 1 about here]

Several categories of food consumption dropped significantly between 2006 and 2009 as food prices increased. As shown in Table 1, the reported daily food consumption for rice fell from 436 gram/day to 390 gram/day, pulses from 231 gram/day to 212 gram/day, and eggs from 108 gram/day to 90 gram/day. In contrast, however, milk and vegetable consumption increased, from 83 ml/day to 94 ml/day and 143 gram/day to 152 gram/day, respectively.

These declines were relatively homogenous across income groups, but create greater absolute nutritional risks among lower income children. In 2009, rice consumption among children in lowest income tertile dropped 10.5%, from 381 g/day to 340 gram per day, whereas in highest income tertile the corresponding fall was 9.8%, from 489 to 441 gram per day. Lower income groups also experienced proportionally greater declines in the consumption of rice, pulses, vegetables and fruits, but an increase in the consumption of milk and meat (Web Appendix figure 1).

In parallel with these trends, figure 2 shows that prior to the increase in prices between 2002 and 2006, the proportion of children who were wasted fell slightly, from 19.4% (95% CI: 17.6% to 21.1%) in 2002 to 18.8% (95% CI: 17.1% to 20.6%). In the subsequent period, when food prices rose markedly, wasting rates rose to 28.0% (95% CI: 26.0% to 30.0%) by 2009. In contrast, consistent with prior studies, we observed a drop in stunting rates during this period, which was plausible since height should not fluctuate adversely in response to short-term changes in food consumption (35.8%, 95% CI: 33.6% to 38.0% in 2006 and 29.2%, 95% CI: 27.1% to 31.2% in 2009).[22]

The observed increase in wasting was disproportionately greater among the low- and middle-income households than in high-income ones. As shown in figure 3, on average prevalence rates of wasting rose in low income groups from 18.4% (95% CI:15.4% to 21.4%) to 29.4% (95% CI:25.9% to 33.0%), in middle income households from 18.9% (95% CI:15.8% to 21.9%) to 31.2% (95% CI:27.6% to 34.7%), and in high income households from 19.2% (95% CI:16.2% to 22.3%) to 23.2% (95% CI:19.9%; 26.5%). These prevalence increases were statistically significant among low (χ^2 (1) = 21.6, p <0.001) and middle income groups (χ^2 (1) = 25.9, p <0.001) but not among the high income groups (χ^2 (1) = 3.08, p = 0.079).

[Figures 2 and 3 about here]

Two Stage Least Squares Regression Models

Did these food price rises correspond to this worsening of children's nutrition? As found from the first stage of the two-stage statistical models and shown in table 2, each 10 rupee increase ($0.17 USD) in the price of rice per kg was associated with a decrease in per capita daily food consumption of rice by 150 grams per day (β = -14.8, 95% CI: -21.6 to -8.1), vegetables by 11 grams (β = -1.1, 95% CI: -1.3 to -0.9), fruits by 2 grams (β =-0.2, 95% CI:-0.4 to -0.2), milk by 30 ml (β =-0.3, 95% CI: -0.4 to -0.2), egg by 2 grams (β =-0.2, 95% CI: -0.2 to -0.1), meat by 1 gram (β =-0.1, 95% CI: -0.1 to -0.1), but an increase in pulses by 3 grams (β =0.3, 95% CI: 0.1 to 0.4) and fish by 1 gram (β =-0.04, 95% CI: 0.01 to 0.06).

In the second stage of the two-stage least squares regression model, we quantified the effect of food consumption on child nutritional risks (Table 3). We found greater per capita daily food consumption in children's weight-for-height Z-score (wasting) in year 2009 compared with 2006. Each additional per capita consumption of 100gm of rice was associated with 0.23 unit (95% CI: 0.04 to 0.43) increase in children's weight-for-height Z-score in year 2009 compared with 2006. Similar trends were observed for the associations of consuming pulses (β = 5.37, 95% CI: 0.60 to 10.15), vegetables (β = 3.30, 95% CI: 0.71 to 5.89) and eggs (β =4.18, 95% CI: 1.06 to 7.31).

[Tables 3 about here]

Discussion

We investigated the effects of food price spikes on children's nutrition in India by applying a two-stage instrumental variable least squares modeling approach. Our statistical models establish that rising food prices negatively affected childhood nutrition across the entire population, and that these nutritional harms were concentrated in deprived groups. Rising food prices corresponded to significant declines in consumption of rice, eggs, meat, which are major sources of caloric intake in Indian diets. In turn, these declines were linked to a worsening risk of children's wasting. These negative effects were disproportionately concentrated in children belonging to low- and middle-income households who had lower food consumption than children belonging to high-income households prior to the food price spikes.

As with any statistical modelling analysis, our study has several limitations. First, the study is not representative of the entirety of India due to the lack of nationally representative, longitudinal data on children's nutrition during the period of interest. However, Andhra Pradesh is a large state of 85 million people,[16] and can well be chosen as a typical Indian state if this is deemed to be possible given the diversity among all Indian states.[23] Andhra Pradesh is approximately in the middle of all Indian states in terms of socio-economic and health indicators,[24] and the Young Lives Study included representative data on all socioeconomic groups in the state. It is likely that the patterns observed here would apply to other Indian states, as household food expenditure would be susceptible to food price changes. This is corroborated by the observation, using nationally representative data, that the proportion of food expenditure to total household expenditure in the country increased from 48.8% in 2005 to 50.7% in 2010, in contrast to the historically declining trends.[19,25] Second, because the data on food expenditures at the household level are based on self-reports, there is a potential for measurement error. However, we expect that this bias would be non-differential across socioeconomic strata, so as to give rise to conservative estimates of the effect of food prices changes on nutritional outcomes. Third, this study was unable to evaluate cross-substitution of food products and household domestic production in the context of increasing unaffordability of food due to limited statistical power. Future research is needed to better understand resilience strategies that households and communities may employ to smooth food consumption in face of economic shocks. Fourth, our study's power did not permit a full investigation of substitution effects across food groups. It is likely that the observed increased consumption of milk and vegetables helped offset a further worsening in wasting during food price rises. Fifth, although standardized z-scores against WHO reference populations were used to adjust directly for ageing and models indirectly corrected for ageing, it is nonetheless possible aging may have biased results. Such bias, however, is likely to be non-differential with respect to associations of food price fluctuations, so yielding conservative estimates. Our analysis also did not reveal significant z-score changes when children aged from approximately 2 – 6 years from 2002 to 2006. Finally, this analysis is likely to understate the magnitude of wasting in association with food price rises because difficult to reach populations, such as persons living in slums, may not be fully captured by the Young Lives survey. Although there was a low attrition rate (4%), these persons were likely to be at higher risk of deteriorating nutrition over the study period.

Our study has important implications for nutritional policy in India and other developing nations. Despite India's remarkable economic growth rate of >5% annually, nutrition has not only stagnated but, as shown in this study, worsened in Andhra Pradesh. Although there have been widespread public concerns about escalating food prices, few studies have sought to understand their impact on children's nutritional outcomes.

Our analysis helps to better account for India's so-called 'growth paradox'. Prior research, using the latest available household level data from 2006, revealed that economic growth across India's states did not correspond to improvements in children's nutritional outcomes.[4] By linking data on malnutrition with rising food prices, our study helps account for why this is so. As food has become relatively more unaffordable, economic growth has not been enough to materially benefit India's most disadvantaged children. In contrast, our study found that nutrition of children living higher income households were not adversely affected by food price rises.

Future research is critically important to understand how to promote resilience to food price rises across Indian states. This is particularly important since World Bank economists predict that, although food prices will fluctuate, prices will remain elevated until at least

2015.[12] It is also possible that food price rises are contributing to a double-burden of over- and under-nutrition. As children age, they may increasingly consume lower cost, energy dense foods, such as sugar-sweetened beverages, thus heightening risks of obesity, diabetes, and cardiovascular disease. India's passage of the 2013 National Food Security Act extends coverage of the Targeted Public Distribution System for larger population to provide rice, wheat and sugar, and special diets for mothers and children.[26] Additionally, multiple interventions target micro-nutrient deficiencies including Vitamin A for pregnant women and iodine deficiency in settings with high malnutrition.[27] Whether these interventions are sufficient to counteract the impact of continued food price rises on overall macro-nutrient consumption in vulnerable children and households is a critical topic for future research.

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Figures and Tables

Figure 1. Food price trends in Andhra Pradesh, India, 2001-2010

Figure 2. Trends in wasting prevalence in children in Andhra Pradesh, India

Figure 3. Trends in prevalence of wasting in children in Andhra Pradesh, India, by income group

Table 1. Descriptive Statistics, DFID Young Lives, Rounds 1-3

Table 2. Effect of price rises on changes in per capita daily consumption of food in year 2009 compared with 2006

Table 3. Effect of food consumption on changes in children’s weight-for-height Z-score in year 2009 compared with 2006, n = 1922 children

Table 1. DFID Young Lives Sample Characteristics

	Round 1 2002	Round 2 2006	Round 3 2009
Number of children	1922	1922	1922
Age in months (SD)	12.3 (3.5)	64.8 (3.8)	96.0 (3.9)
Male	53.1%	53.1%	53.1%
Urban	24.1%	25.3%	26.1%
Mother's Education			
Illiterate	51.1%	n/a	n/a
Lower primary school	10.2%	n/a	n/a
Upper primary school	16.0%	n/a	n/a
Secondary/higher secondary	19.3%	n/a	n/a
College/university	3.2%	n/a	n/a
Ethnicity/Caste		n/a	n/a
Mixed caste	0.1%	n/a	n/a
Schedule caste	17.9%	n/a	n/a
Schedule tribe	13.0%	n/a	n/a
Backward caste	47.9%	n/a	n/a
Other caste	20.9%	n/a	n/a
Childhood nutrition			
Weight-for-height Z-score (SD)	-1.0 (1.2)	-1.2 (1.0)	-1.4 (1.2)
Height-for-age Z-score (SD)	-1.3 (1.6)	-1.6 (1.1)	-1.4 (1.2)
Wasting prevalence	19.4%	18.8%	28.0%
Stunting prevalence	30.1%	35.8%	29.2%
(Changes in Food Consumption (100 g / ml per day)			
Rice	n/a	4.361 (8.472)	3.904 (2.941)
Pulses	n/a	0.231 (0.267)	0.212 (0.178)
Meat	n/a	0.119 (0.230)	0.125 (0.121)
Milk	n/a	0.831 (1.223)	0.943 (1.113)
Fish	n/a	0.047 (0.129)	0.044 (0.091)
Egg	n/a	0.108 (0.481)	0.090 (0.115)
Vegetables	n/a	0.143 (0.092)	0.152 (0.081)
Fruits	n/a	0.134 (0.196)	0.121 (0.164)
Food Prices (rupees/kg or litre)			
Rice	16.5 (1.2)	17.4 (1.9)	23.8 (2.7)

Pulses	41.1	46.1	78.3
	(1.5)	(3.3)	(2.8)
Meat	135.7	139.5	172.7
	(14.9)	(8.3)	(14.3)
Fish	68.9	75.0	88.8
	(41.3)	(45.8)	(34.7)
Egg	28.0	26.0	47.1
	(0.7)	(1.9)	(9.5)
Milk	19.8	17.1	20.8
	(2.5)	(1.9)	(4.6)
Vegetables	11.2	12.4	19.4
	(0.7)	(1.1)	(2.6)
Fruits	19.3	21.5	28.9
	(2.8)	(3.5)	(2.2)

Table 2. Effect of price rises on changes in per capita daily consumption of food in year 2009 compared with 2006

	Change in Daily Percapita Consumption (gm or ml)							
	Rice	Pulses	Vegetables	Fruits	Milk	Egg	Meat	Fish
Change in price of Food Item (per kg/litre)	-14.84***	0.28***	-1.11***	-0.23*	-3.04***	-0.18***	-0.07**	0.04**
	(3.42)	(0.084)	(0.10)	(0.11)	(0.47)	(0.03)	(0.02)	(0.015)
High Income	ref	ref	ref	ref	ref	ref	ref	ref
Middle income	-56.02**	-2.27*	-0.94	-4.87***	-55.7***	-5.20***	-2.26**	-1.54**
	(19.25)	(1.13)	(0.49)*	(1.01)	(6.23)	(0.70)	(0.77)	(0.57)
Low income	-122.1***	-5.47***	-1.53**	-7.39***	-72.7***	-7.35***	-3.72***	-3.96***
	(21.4)	(1.20)	(0.52)	(1.07)	(6.61)	(0.74)	(0.08)	(0.60)
Age	-0.53	-0.18	0.08	0.03	0. 20	-.02	0.14	0.02
	(1.67)	(0.10)	(0.04)	(0.09)	(0 .56)	(0.10)	(0.10)*	(0.05)
Urban	-30.28	-3.30***	1.00*	1.67	47.04***	-0.15	0.97	-1.83***
	(19.02)	(1.14)	(0.49)	(1.01)	(6.27)	(0.70)	(0.76)	(0.57)
Male	20.75	0.23	0.20	-1.26	6.20	-0.40	0.40	0.22
	(13.14)	(0. 80)	(0.35)	(0.72)	(4.4)	(0.49)	(0.54)	(0.40)
Household size	-12.93***	-1.06 ***	-0.89***	-0.86***	-5.8***	-0.82***	-0.53***	-0.63***
	(2.96)	(0. 18)	(0.07)	(0.16)	(1.00)	(0.11)	(0.53)	(0.10)
R^2	0.05	0.03	0.14	0.09	0.26	0.11	0.04	0.05

Notes: Estimates reported from first stage of the 2SLS model with food price as instrument variable. Standard errors in parentheses. Constant estimated but not reported.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3. Effect of food consumption on changes in children's weight-for-height Z-score in year 2009 compared with 2006, n = 1922 children

	Change in weight-for-height Z-score *wasting is defined as weight-for-height Z-score ≤ -2*							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Food items	Rice	Pulse	Vegetables	Fruits	Milk	Egg	Meat	Fish
Change in Food Consumption (in 100 g/ml)	0.23^{*} (0.099)	5.38^{*} (2.44)	3.30^{*} (1.32)	-1.38 (3.31)	0.23 (0.17)	4.18^{**} (1.60)	-12.5^{*} (5.26)	5.28 (4.87)
High income	ref	ref	ref	ref	ref	ref	ref	ref
Middle income	-0.018 (0.087)	0.017 (0.10)	-0.073 (0.072)	-0.16 (0.17)	0.026 (0.12)	0.12 (0.11)	-0.38^{*} (0.17)	-0.015 (0.11)
Low income	0.11 (0.12)	0.18 (0.16)	-0.061 (0.076)	-0.19 (0.25)	0.063 (0.14)	0.20 (0.14)	-0.56^{*} (0.23)	0.12 (0.21)
R^2	0.05	0.03	0.14	0.09	0.26	0.11	0.04	0.05

Notes: Estimates reported from second stage of the 2SLS model with food price as instrument variable. Standard errors in parentheses. Constant estimated but not reported.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The models are adjusted for age, location, sex, and household size.