Child Nutrition and Local Food Prices in Nepal

Ganesh Thapa
Consultant
International Food Policy Research Institute
Kathmandu Nepal

Gerald Shively
Professor
Department of Agricultural Economics
Purdue University
West Lafayette, IN 47907

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ABSTRACT

This paper studies the connections between child nutrition and food prices in Nepal. Data from a number of sources are combined, including the 2006 and 2011 Nepal Demographic Health Surveys and monthly retail food price data collected over the period 2002 to 2010 from 34 districts of Nepal. A total of 4,038 children are used for the analysis (2,765 from 2006 and 1,273 from 2011). Price data are selected for six food commodities important for child nutrition outcomes: coarse rice, wheat flour, sugar, ghee, soybean and milk. Separate regression results are reported for survey years, subsets of poor and non-poor households, subsets based on land holdings, and children with before and after their first 1000 days. Evidence regarding the impacts of food prices on child nutrition outcomes are mixed. Milk prices are negatively associated with both short-term and long-term child nutrition outcomes. Coarse rice prices are negatively correlated with short-term child nutrition outcomes in food deficit districts, but coarse rice prices are positively associated with short-term nutrition outcomes in food surplus districts, underscoring the importance of higher producer prices among net-sellers.

Key Words**:** Malnutrition, height-for-age, weight-for-height, food prices, Nepal

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1. Introduction

Child malnutrition rates in Nepal are among the highest in the world. Approximately 41% of children less than five years of age are stunted (a measure of chronic malnutrition) and 12% are underweight (a measure of acute malnutrition). The stunting rate is even higher (about 60%) in Nepal's mountainous region (NDHS 2011). Such a pattern is of serious concern as it negatively affects the human capital formation process required for prosperity and economic growth (Galler and Barrett 2001). Policy makers and concerned agencies in Nepal continue to explore various pathways to improve child nutrition outcomes in the country.

A majority of Nepalese households are net buyers of food and depend on markets for their food purchases (CBS 2011). As a result, market performance and food prices directly influence levels of household consumption. These, in turn, can influence nutrition outcomes. Given the potentially deleterious effects of high food prices on child nutrition outcomes in food-purchasing households, one of the important pathways to reducing child malnutrition rates over time is likely to be by increasing market efficiency and reducing food prices for poor consumers. A number of studies have documented a negative association between food prices and child nutrition outcomes. Higher sugar and dairy prices were associated with lowered child height in Brazil (Thomas and Strauss 1992); higher food prices were found to be detrimental to short-term child nutrition outcomes (weight-for-height) in Cote d'Ivoire (Thomas et al. 1992); increases in prices of plantain and sugar were found to negatively affect short-term child nutrition outcomes in rural areas of Ghana (Lavy et al. 1996); and food price increases had negative impacts on child health in Kenya (Grace et al. 2014). According to WFP/NDRI (2008), recent price increases in Nepal have forced people to buy cheaper and lower-quality food items, suggesting potentially deleterious nutritional impacts as a result. Children from food deficit districts can be severely affected while children from food surplus districts may be benefitted from rise in food prices. Figure 1 shows the positive relationship between the coarse rice prices and WHZ in food surplus districts and negative relationship between the coarse rice prices and WHZ in food deficit districts. Generally we expect that rise in food prices matters more for poor households than that of rich households. An additional perspective on this relationship is provided by figure 2, which plots WHZ against rice prices for children in the bottom quintile of the wealth distribution and those in the top quintile of the wealth distribution. The poorest households tend to be net-buyers of food, and are therefore harmed by higher food prices, and the richest households tend to be net-sellers of food, and are therefore helped by higher food prices.

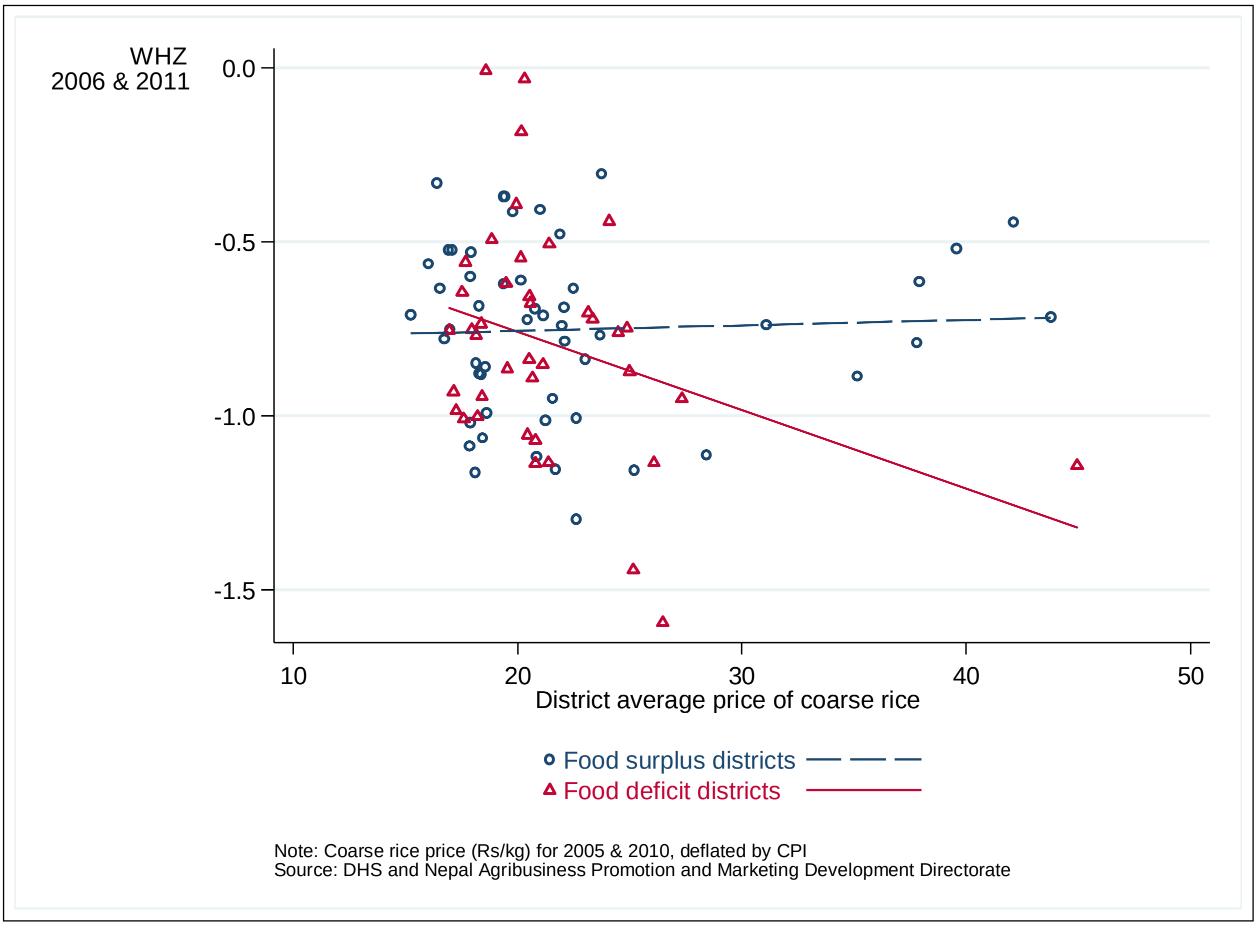

Figure 1: District average WHZ and price of coarse rice in food surplus and deficit district

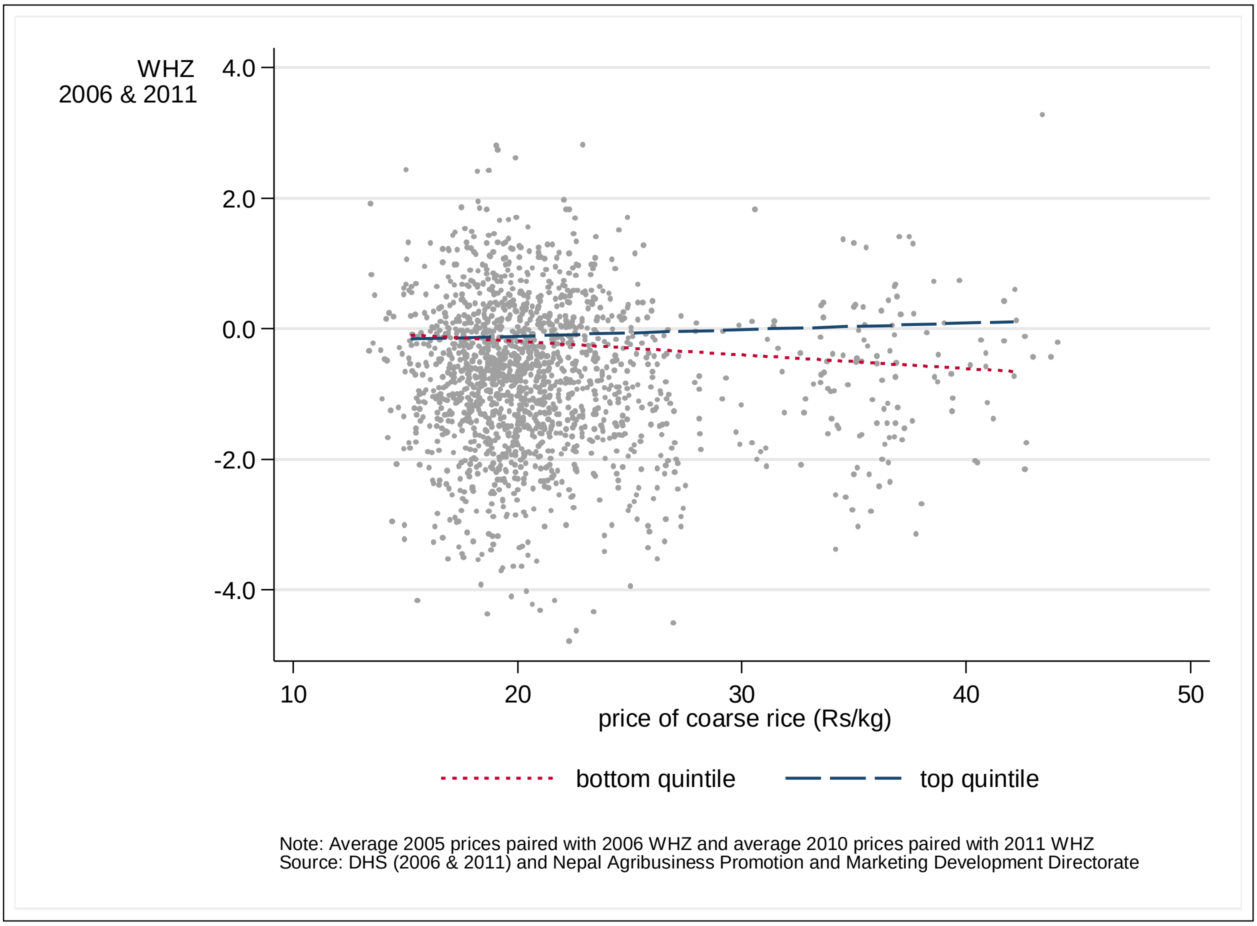

Figure 2: Rice prices and WHZ for children in top and bottom wealth quintiles, 2011

As figures 3 and 4 illustrate, there is a high degree of spatial variation in food prices and food price variability in Nepal. High transportation costs and poorly functioning markets are often blamed for these outcomes, a conjecture that is supported by recent econometric evidence on price transmittal in Nepal (Shively and Thapa, in press). Given the important role of markets and food prices on child nutrition outcomes, it is surprising that no attention has been focused on understanding the connections between price and nutrition outcomes in Nepal (Sah 2005; Singh et al. 2009; Shively and Sununtnasuk 2015; Shively et al. 2015; Thapa 2016). To address the research gap that remains, the main objective of this study is to examine the patterns of association between food prices and child nutrition outcomes of children under age five in Nepal.

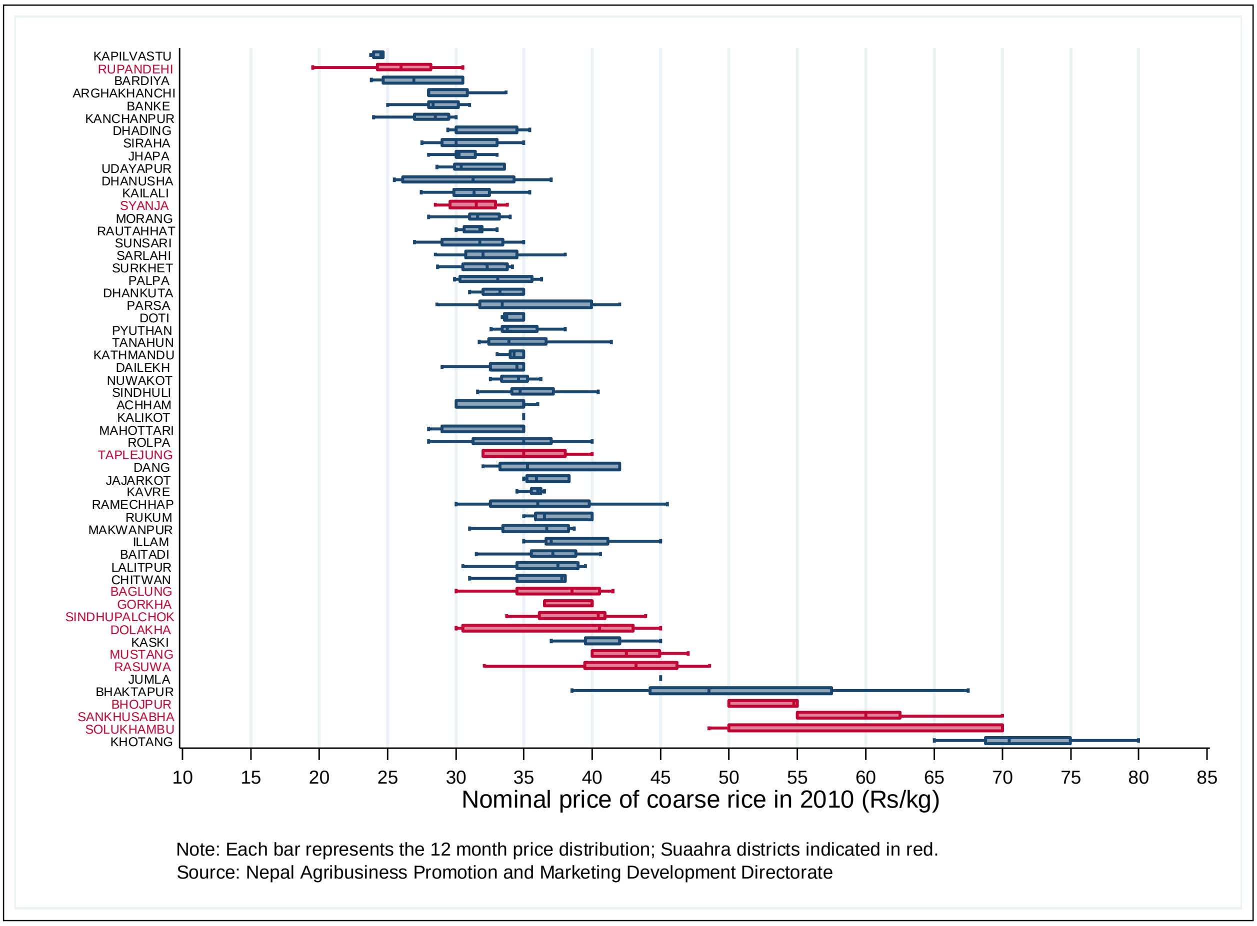

Figure 3: Nominal price of coarse rice by district in 2010

Our indicator of short-term nutrition is the weight-for-height z-score (WHZ). Our indicator of long-term nutrition is the height-for-age z-score (HAZ). We selected six food commodities (coarse rice, wheat flour, sugar, soybean, milk and ghee) that are expected to be important for child nutrition outcomes. For WHZ, we match observations to annual average prices observed in the year prior to child measurement. For HAZ, we match observations to annual average prices observed in the year of the child's birth. We separately assess the correlations between z-scores and food prices for each survey year (2006 and 2011), for the samples of children from large and small farms (below and above 0.8 ha), for children below and above the first 1000 days since conception, and for separate sub-samples of children from food deficit and food surplus districts and poor and non-poor households. The analysis provides a rigorous and robust check of the influence of food prices on child nutrition outcomes in Nepal.

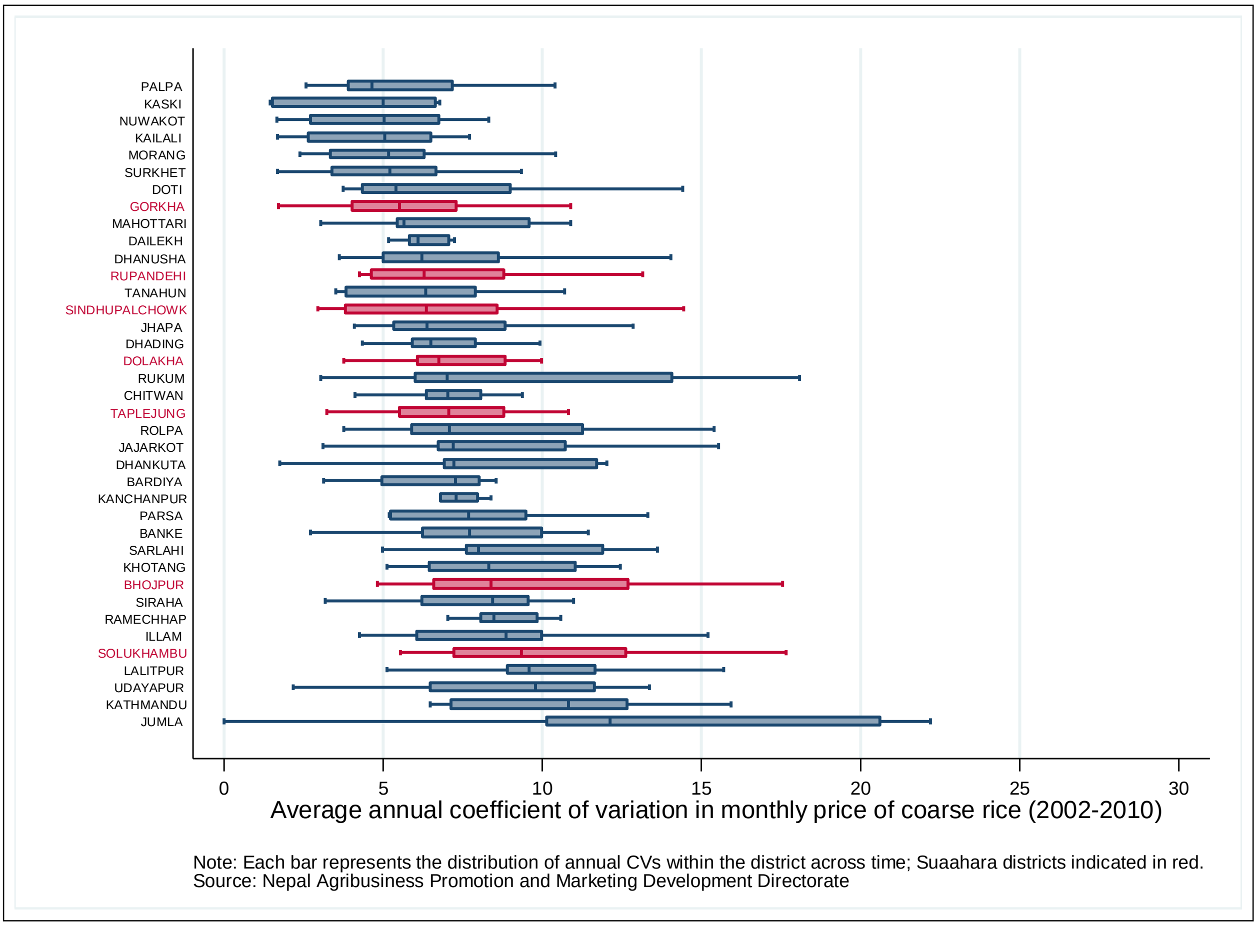

Figure 4: Variation in real price of coarse rice by district 2002-2010

2. Conceptual Framework

We begin with a conceptual framework based on the household model proposed by Becker (1965). In the model, each household maximizes its utility function represented as:

$$U = U(H, X^c, Y, l) \quad (1)$$

where H is the level of health, X^C is the consumption of the produced food commodity X, Y is a vector of purchased food commodity and l is leisure.

The level of health is expected to depend on the levels of X^c and Y consumed, a vector of environmental factors and health endowment μ that is beyond the control of the household. The household health production function is represented as:

$$H = h(X^c(.), Y(.), l) + \mu \quad (2)$$

The quantity of X^Cconsumed and Y purchased depends on the market prices. If a household is a net-buyer, higher prices are likely to reduce the purchase of Y. However higher food prices are also likely to increase the consumption of X^c for net-sellers. Each household faces an income constraint represented as:

$$p_x X^c(p_x) + p_y Y(p_y) = w(L - l) + M = I \quad (3)$$

Where p_x and p_y are market prices of X^c and Y; w is the market wage rate, L is the total time endowment available, M is income from non-farm sources and I is total income. We assume that household separability holds, and that households are simply the price takers in food and labor markets.

We assume that the household utility function meets all the properties (continuity, differentiability and quasi-concavity) and maximize its utility subject to equations (2) and (3). The first order conditions from the utility maximization are then used to derive the reduced-form demand equations for H as follows:

$$H = d_H(p_x, p_y, I, \mu) \quad (4)$$

where health level is a function of prices, income, household characteristics, leisure, the health environment and the natural environment. Here H is the health level of overall household. If H is assumed to be a composite production function of household members and similarly μ is a composite of individual health endowments, then the child health function is represented as:

$$H_{ch}^{i} = d_{H}^{i}\left(p_x^i, p_y^i, I^i, \mu^i\right) \tag{5}$$

Smith and Haddad (2000) presented a framework where child's nutritional status is influenced by child characteristics, household characteristics and district characteristics. We further extended the reduced form of child health equation by including the above determinants as follows:

$$H_{ch}^{i} = d_{H}^{i}\left(p_x^i, p_y^i, I^i, C_c^i, M^i\ , H^i\ , D^i\ , \mu^i\right) \tag{6}$$

where C_c^i are child characteristics, M_M^i are mother characteristics, H_H^i are household characteristics, and D_c^i are district characteristics. Since, child health status can be well reflected by the measure of child nutrition outcomes (HAZ and WHZ), the child health equation can be well-represented by the child nutrition outcomes equation.

Price changes will indirectly affect the child nutrition via influencing the consumption and purchase of the goods X and Y. We can express change in child nutrition outcomes in terms of the marginal product of X^c, Y, l, μ as follows:

$$\mathrm{d}H_{ch}^{i} = h_{X^c}\,\mathrm{d}X^c + h_Y\,\mathrm{d}Y + h_l\,\mathrm{d}l + h_\mu\,\mathrm{d}\mu \tag{7}$$

Finally, the effects of price on the child health (nutrition outcomes) can be decomposed as follows:

$$\frac{\mathrm{d}H_{ch}^{i}}{\mathrm{d}p_t} = h_{X^c}\frac{\mathrm{d}X^c}{\mathrm{d}p_t} + h_Y\frac{\mathrm{d}Y}{\mathrm{d}p_t} + h_l\frac{\mathrm{d}l}{\mathrm{d}p_t} + h_\mu\frac{\mathrm{d}\mu}{\mathrm{d}p_t} \tag{8}$$

Where $t = x, y$ and $\frac{\mathrm{d}\mu}{\mathrm{d}p_t} = 0$.

Equation 8 yields

$$\frac{\mathrm{d}H_{ch}^{i}}{\mathrm{d}p_x} = h_{X^c}\frac{\mathrm{d}X^c}{\mathrm{d}p_x} + h_Y\frac{\mathrm{d}Y}{\mathrm{d}p_x} + h_l\frac{\mathrm{d}l}{\mathrm{d}p_x} \tag{9}$$

$$\frac{\mathrm{d}H_{ch}^{i}}{\mathrm{d}p_y} = h_{X^c}\frac{\mathrm{d}X^c}{\mathrm{d}p_y} + h_Y\frac{\mathrm{d}Y}{\mathrm{d}p_y} + h_l\frac{\mathrm{d}l}{\mathrm{d}P_y} \tag{10}$$

The net effect of prices on the child nutrition outcomes is ambiguous as the price change of one food item will not only have its own and cross price effects but can also positively or negatively influence the marginal productivities of health inputs. We measure the association between child nutrition outcomes and prices of important food commodities.

3. Empirical strategy

We estimated series of models using ordinary least squares (OLS) regression technique. The dependent variables are height-for-age (HAZ) and weight-for-height, the measure of short- and long-term child nutrition outcomes, respectively. We first implement a parsimonious regression by just incorporating food prices. We then add a series of explanatory and control variables to account for child-, mother-, and household characteristics. We also control for district infrastructure (including road density). Although our intention was to implement Zellner's seemingly unrelated regression (SUR) approach to take an account of potential error correlation between the HAZ and WHZ equations, Breusch-Pagan tests of independence supported accepting the null hypothesis of no significant error correlation between these two equations (chi2(1) = 0.026, Pr = 0.8731). We therefore estimated the HAZ and WHZ equations separately, as follows:

$$\boldsymbol{Z} = \boldsymbol{\alpha P} + \boldsymbol{\varepsilon} \tag{11}$$

Where $\boldsymbol{Z}$ is the vector of dependent variables (HAZ and WHZ), $\boldsymbol{P}$ is the vector of prices, $\boldsymbol{\alpha}$ is the vector of parameters including the constant term to be estimated, $\boldsymbol{\varepsilon}$ is the column vector of error terms and assumed to be independently and identically distributed across the observations. It is very important to mention that we did not use the same set of price variables in HAZ and WHZ equations. In the case of the WHZ equation, we used annual prices observed in 2005 for children sampled in 2006 and annual prices observed in 2010 for child surveyed in 2011. For HAZ, we matched the child nutrition data with the prices observed in the year of birth. Since WHZ is a measure of short-term nutrition outcomes, we expect the lagged food price to matter for WHZ. While HAZ is a measure of long-term nutrition outcomes, we expect the food prices observed in the year of birth to matter for HAZ.

In addition to the food prices in equation 11, we added variables at the child, mother, household, and district levels to control their influences on the child nutrition outcomes as follows:

$$\boldsymbol{Z} = \boldsymbol{\alpha P} + \boldsymbol{\beta C} + \boldsymbol{\gamma M} + \boldsymbol{\delta H} + \boldsymbol{\theta D} + \boldsymbol{\varepsilon} \tag{12}$$

Where $\boldsymbol{C}$ is the vector of child level variables, $\boldsymbol{M}$ is the vector of mother level variables, $\boldsymbol{H}$ is the household related variables, and $\boldsymbol{D}$ is the district level variables. Our aim is to control for many factors as possible and estimate the causal impact of food prices on child nutrition outcomes as closely as possible. The variables used in equation 12 are defined and discussed in Section 5.

Since children born before 2006 might have been negatively affected by the 10-year long Maoist conflict in Nepal, we estimated separate regressions for children surveyed in 2006 and 2011. The effect of food prices on child nutrition may significantly differ for poor and non-poor households, before and after the first 1000 days of life, and across farm sizes. Therefore, we also separately estimated equation12 for sub-samples: (i) poor and non-poor households, (ii) before and after the first 1000 days of a child's life, (iii) food surplus and deficit districts, and (iv) agricultural landholdings of less than and greater than 0.8 hectare. Although we were not able to decompose the results by net producers versus net consumers to see how prices play differently on nutrition for these different types of households, we expect that households with average landholdings of less than 0.8 hectare should be net consumers. We estimate and report robust standard errors, using White's correction for heteroskedasticity.

4. Data

We work with annual retail prices for coarse rice, wheat flour, ghee, milk, soybean and sugar from 2002 to 2010. Since these food commodities are commonly consumed by children, we expect their prices to potentially influence child nutrition outcomes by affecting food consumption. Price data were obtained from the Nepal Agribusiness Promotion and Marketing Development Directorate and cover 34 districts (11 from the Terai belt, 18 from the Hilly belt and 5 from the Mountainous belt). Remaining districts were excluded from the analysis due to missing price information for a complete year. Our price data seem fairly representative of all of the ecological belts of the country; however, we do not claim our data or analysis to be nationally representative. Nominal prices were deflated using the country-wide consumer price index (CPI).[1]

We obtained data on child growth as well as information on child-, mother-, and household-specific variables from two rounds of the Nepal Demographic Health Surveys (NDHS) conducted in 2006 and 2011. The NDHS surveys are comprehensive and nationally representative household surveys carried out in more than 70 countries. In Nepal, the survey was administered by the Ministry of Health and Population (MOHP) using a two-stage stratified sample of households. The questionnaires provide detailed and comparable statistics on various aspects of human health, health behavior and nutrition across all ecological zones and development regions of Nepal.

[1] A small number of missing prices (n=1822 out of 22032 observations total) were interpolated using predicted values obtained from a regression of price on month, year, and district indicators. Districts used in the analysis were: Banke, Bhojpur, Chitwan, Dailekh, Dhading, Dhankuta, Dhanusha, Dolakha, Doti, Gorkha, Illam, Jajarkot, Jhapa, Jumla, Kailali, Kanchanpur, Kaski, Kathmandu, Khotang, Mahottari, Morang, Nuwakot, Palpa, Parsa, Ramechhap, Rolpa, Rukum, Rupandehi, Sarlahi, Sindhupalchowk, Solukhambu, Surkhet, Taplejung and Udaypur.

We have a total of 4,038 children in our sample: 2,765 children measured in 2006 and 1,273 children measured 2011. Although the NDHS is a nationally representative household survey, we were only able to use the child nutrition information from 34 districts to pair with the district level food price data. We also incorporated annual, district-level data on roads to control for the effects of road infrastructure on child nutrition outcomes. Annual, district-level data on roads were obtained from the Department of Road (DOR), Ministry of Physical Planning, Works and Transport Management. The DOR publishes Nepal Road Statistics (NRS) in alternate years.

5. Descriptive Results

Table 1 provides a brief description and descriptive statistics of the variables used in the analysis. Among the prices of six food commodities, the price of animal ghee is the highest followed by sugar, soybean, milk, wheat flour and coarse rice. The mean, standard deviation and range slightly vary between the prices observed for the child born year and the lagged survey year.

The average WHZ in our unweighted sample is -0.76 with a standard deviation of 1.09 while the average HAZ is -1.82 with a standard deviation of 1.35. Thirty-two percent of the children were observed in 2011; 51% of children in the sample are male; and the average age of a child is about 30 months. Twenty eight percent of children sampled were born in the monsoon season (July August and September), 22% were born in the summer season (April, May and June) and 25% were born in the autumn season (October, November and December). Out of the total sample, about one percent of the children were twin births. On average, a child received about seven vaccines. Twelve percent of children had diarrhea in the previous two weeks while nineteen percent had fever in previous two weeks.

About 24% of the mothers were found to be housewives and not employed in agriculture and non-farm activities. Sixty-seven percent of mothers in the sample are employed in agriculture. The largest percentage of households is from the unprivileged group (26%), followed by Mongolian (24%), Chetri (19%) and Brahmin (16%). Mother in the sample were, on average, 27 years old (minimum 15; maximum 49). Average mother's education is just 3 years (range 0-14).On average, households had three children (maximum 13). About 79% of children are found to be breast-feeding. About 67% of households have a husband living at home. Seventy-three percent of children were delivered at home. This may be due to the lack of awareness or distant location of health facilities. Female heads account for 23% of households in the sample.

Twenty-six percent of children are from an urban location. Fifty-two percent of the households defecate in an open environment. Eighty-six percent of the households use smoke-producing fuels. Thirteen percent of households drink treated water. Fifty-two percent of households have access to electricity and sixty percent of household uses bed net. Seventy-nine percent of households rear livestock. About half of the surveyed households own a bank account and sixty-seven percent of household's own land. Forty-seven percent of the households falls within the lower fourth and fifth wealth quintile and are considered as poor. The average altitude of residence is 732 meters above sea level (minimum 46; maximum 2571).

We incorporated road-related variables, agro-ecological zone and an indicator of whether the district of residence was food deficit or food surplus. The average road density in the child's birth year was 0.12 (km/km2) while the average road density in child's year of measurement was 0.14 (km/km2).About 42% of the districts are food deficit while 58% of the districts are food surplus.

Table 1: Definition and descriptive statistics of the variables used in the analysis

Variables	Obs	Mean	Std. Dev.	Min	Max
Food Prices					
Real prices of Animal Ghee (Rs/Kg) observed in child born year	4037	256.40	48.14	139.37	424.78
Real prices of Milk (Rs/lit) observed in child born year	4037	25.10	4.48	15.58	49.56
Real prices of coarse rice (Rs/Kg) observed in child born year	4037	20.63	6.47	13.94	54.94
Real prices of soyabean (Rs/Kg) observed in child born year	4037	36.39	7.55	21.91	81.42
Real prices of wheat flour (Rs/Kg) observed in child born year	4037	21.74	7.67	14.32	65
Real prices of Sugar (Rs/Kg) observed in child born year	4037	37.93	7.79	25.28	74.79
Real prices of Animal Ghee (Rs/Kg) observed in lagged survey year	4037	261.68	46.86	180.00	386.22
Real prices of Milk (Rs/lit) observed in lagged survey year	4037	25.12	4.64	16.61	45.06
Real prices of coarse rice (Rs/Kg) observed in lagged survey year	4037	21.18	5.82	16.00	45.38
Real prices of soyabean (Rs/Kg) observed in lagged survey year	4037	37.78	7.83	25.00	74.03
Real prices of wheat flour (Rs/Kg) observed in lagged survey year	4037	21.83	7.65	15.50	65.00
Real prices of Sugar (Rs/Kg) observed in lagged survey year	4037	41.39	6.42	33.80	70.00
Child level					
Height-for-age Z-score	4037	-1.82	1.35	-5.96	4.59
Weight-for-height Z-score	4037	-0.76	1.09	-4.88	3.7
Observation for 2011†	4037	0.32	0.46	0	1
Male child†	4038	0.51	0.50	0	1
Child age(months)	4037	29.93	17.13	0	59
Child age (months square)	4037	1189.44	1057.04	0	3481
Born season (monsoon) †	4038	0.28	0.45	0	1
Born season (summer) †	4038	0.22	0.42	0	1
Born season (autumn) †	4038	0.25	0.43	0	1
Born twin†	4037	0.01	0.08	0	1
Total vaccines received	4037	6.89	2.24	0	8
Had diarrhea in last two weeks†	4037	0.12	0.32	0.00	1.00
Had fever in last two weeks†	4037	0.19	0.40	0.00	1.00
Mother level					
Mother do not work†	4038	0.24	0.43	0	1
Mothers works in agriculture†	4038	0.67	0.47	0	1
Continued.					

Variables	Obs	Mean	Std. Dev.	Min	Max
Mother ethnicity is Brahmin†	4038	0.16	0.36	0	1
Mother ethnicity is Mongoloid†	4038	0.24	0.43	0	1
Mother ethnicity is from Chettri†	4038	0.19	0.39	0	1
Mother ethnicity is from lower cast†	4038	0.26	0.44	0	1
Age of mother in years	4037	26.91	5.98	15	49
Square of mother age	4037	759.83	356.23	225	2401
Mothers education in single years	4037	3.11	3.95	0	14
Total children ever born in the family	4037	2.94	1.89	1	13
Mother smokes cigareetes†	4037	0.13	0.34	0	1
Currently mother is breast feeding†	4037	0.79	0.41	0	1
Husband living with wife at home†	4038	0.67	0.47	0	1
Mother delivers baby at home†	4038	0.73	0.44	0	1
Female heads household†	4037	0.23	0.42	0	1
Household level					
Urban area†	4037	0.26	0.44	0	1
Defecating in open environment†	4038	0.52	0.50	0	1
Smoke producing fuels†	4038	0.86	0.35	0	1
Anything done to water to make safe to drink†	4037	0.13	0.34	0	1
Has electricity facility†	4037	0.52	0.50	0	1
Has bed net†	4037	0.60	0.49	0	1
Household rear livestock†	4037	0.79	0.41	0	1
Household owns a bank account†	4037	0.49	0.50	0	1
Own land usable for agriculture†	4037	0.67	0.47	0	1
Poorest and poorer wealth category†	4038	0.47	0.50	0	1
Altitude (meters)	4037	731.54	694.54	46.03	2571.00
District Level					
Road density index in born year (km/km2) †	4037	0.12	0.28	0	1.97
Road density index in surveyed year (km/km2) †	4037	0.14	0.34	0	1.97
District from Hill†	4037	0.27	0.45	0	1
District from Mountain†	4037	0.08	0.27	0	1
District is food deficit†	4038	0.42	0.49	0	1

Note:† Denotes a binary variable. Z-scores > 6.0 or < -6.0 removed from the dataset.

6. Empirical Results

Table 2 presents the regression results for the parsimonious and full models for both the HAZ and WHZ. While comparing the results between parsimonious and full models, we find changes in magnitude, sign and significance of some of the coefficients of food price variables. This suggests the need to control for omitted variables like transportation, agro-ecology, child, mother and household characteristics, of which some are likely to be correlated with the food prices, child nutrition outcomes or both. We only interpret the results from the full model (Model 1B and Model 2B). For HAZ, we found wheat flour price to be negatively associated with the long-term child nutrition outcomes at 10% level of significance. The rise of wheat flour prices by one rupees is correlated with the decrease of WHZ by 0.009. However for WHZ model, the price of wheat flour was positively associated with the short-term child nutrition outcomes at 10% level of confidence. A one-rupee increase in the price of wheat flour is correlated with the increase of WHZ by 0.01. The coefficient of milk price and sugar price was negative and statistically significant at less than 10% level suggesting potentially deleterious impacts from a rise in milk and sugar prices on short-term child nutrition outcomes. Although our main objective is to assess the relationship between food prices and child nutrition outcomes, we also briefly discuss other factors that are positively and negatively associated at less than 10% level of significance. The factors positively associated with HAZ at the standard level of statistical significance are mothers' education, husband living with wife at home, drinking treated and safe water and household rearing livestock. Similarly the factors negatively associated with HAZ at the standard level of statistical significance are unemployed mothers, mothers working in farm, total number of children in the family, mothers smoking cigarettes, currently breast feeding, baby delivering at home, poor households, food deficit district and altitude. For WHZ model, the factors that are positively associated with the short-term nutrition outcomes are wealth index, road density and altitude. Similarly the factors that are negatively associated with the WHZ are child born in monsoon and autumn season, child born as twin, had fever in last two weeks, husband living with wife at home and open defecation.

Table 2: Regression results on factors influencing child nutrition outcomes (main model results)

	HAZ		WHZ	
VARIABLES	Model 1A	Model 1B	Model 2A	Model 2B
Price of Animal Ghee in Rs/Kg	0.00167***	-0.00057	0.00018	0.00031
	(0.00045)	(0.00043)	(0.00043)	(0.00044)
Price of Milk in Rs/liter	-0.00726	-0.00379	0.00242	-0.00771*
	(0.00505)	(0.00467)	(0.00416)	(0.00429)
Price of Coarse Rice in Rs/Kg	-0.01171*	0.00469	-0.00661	0.00823
	(0.00679)	(0.00654)	(0.00617)	(0.00631)
Price of Soybean in Rs/Kg	0.01879***	0.00112	0.01261***	-0.00229
	(0.00312)	(0.00292)	(0.00267)	(0.00310)
Price of Wheat Flour in Rs/Kg	-0.0347***	-0.00896*	0.00362	0.01050*
	(0.00511)	(0.00492)	(0.00481)	(0.00582)
Price of Sugar in Rs/Kg	0.03006***	0.00359	0.01027*	-0.0296***
	(0.00456)	(0.00497)	(0.00556)	(0.00761)
Year 2011(1=2011; 0 otherwise)		0.12729**		0.46842***
		(0.05967)		(0.07436)
Urban/rural (0=rural, 1=urban)		0.05611		0.01172
		(0.05428)		(0.04823)
Gender (1=Male, 0=Female)		-0.00852		0.02386
		(0.03642)		(0.03223)
Age in months		-0.09335***		0.00393
		(0.00530)		(0.00443)
Square of child age		0.00113***		0.00003
		(0.00008)		(0.00007)
Child born season(1=Monsoon, 0 otherwise)		-0.01214		-0.09103**
		(0.05033)		(0.04455)
Child born season(1=Summer, 0 otherwise)		0.02333		-0.05749
		(0.05098)		(0.04718)
Child born season(1=Autumn, 0 otherwise)		0.01616		-0.15621***
		(0.05223)		(0.04577)
Child born twin(1=born twin,0 single)		-0.00743		-0.41733*
		(0.22526)		(0.22492)
Number of vaccines received		0.01638		-0.01863**
		(0.01033)		(0.00874)
had diarrhea in last two weeks (0/1)				-0.07213
				(0.05454)
had fever in last two weeks (0/1)				-0.14840***
				(0.04239)
Mothers not working (1=yes; 0=no)		-0.15459**		-0.10561
		(0.07330)		(0.06646)

Continued.

	HAZ		WHZ	
VARIABLES	Model 1A	Model 1B	Model 2A	Model 2B
Mother ís working in farm (1=yes; 0=no)		-0.19217***		-0.05849
		(0.07392)		(0.06636)
Ethnicity: Brahmin,(1=Brahmin; 0 otherwise)		-0.12964*		0.18952***
		(0.07200)		(0.06670)
Ethnicity: Mongoloid,(1=Mongoloid; 0 otherwise)		-0.05953		0.52929***
		(0.06840)		(0.06002)
Ethnicity: Chhetri,(1=Chhetri; 0 otherwise)		-0.09736		0.27401***
		(0.06753)		(0.06278)
Ethnicity: Unprivileged,(1=Unprivileged;0 otherwise)		-0.15361**		0.29541***
		(0.06167)		(0.05555)
Age of mother in years		0.05950**		-0.01149
		(0.02499)		(0.02124)
Square of mothers age		-0.00085**		0.00019
		(0.00042)		(0.00035)
Mothers' education in single years		0.03759***		0.00905
		(0.00661)		(0.00616)
Total children ever born in the family		-0.05697***		-0.01662
		(0.01634)		(0.01363)
Mother smokes cigarettes (1=yes; 0=no)		-0.25128***		0.09044*
		(0.05607)		(0.04842)
Currently breast feeding,(1=yes; 0=no)		-0.24790***		-0.04037
		(0.05110)		(0.04284)
Husband living with wife at home,(1=yes; 0=no)		0.09134*		-0.12768***
		(0.04833)		(0.04442)
Place of delivery (1=at home,0=not at home)		-0.17084***		-0.01592
		(0.05064)		(0.04566)
Female headed household (1=yes; 0=no)		-0.00896		-0.03745
		(0.05122)		(0.04786)
Open defecation, (1=yes; 0=no)		-0.03813		-0.07552*
		(0.04734)		(0.04228)
Smoke producing fuels,(1=yes;0=no)		-0.06451		0.10635
		(0.08344)		(0.07628)

Continued.

	HAZ		WHZ	
VARIABLES	Model 1A	Model 1B	Model 2A	Model 2B
Anything done to water to make safe to drink, (1=yes; 0=no)		0.11760*		0.06563
		(0.06295)		(0.05871)
Has electricity facility (1=yes; 0=no)		-0.01242		0.04378
		(0.05296)		(0.04546)
Has bed net for sleeping (1=yes; 0=no)		0.02364		-0.02108
		(0.05321)		(0.04473)
Household rear livestock (0/1)		0.17516***		-0.02265
		(0.06128)		(0.05415)
Household owns a bank account (1=yes; 0=no)		0.04569		-0.04095
		(0.04180)		(0.03659)
Own land usable for agriculture (1=yes; 0=no)		-0.00848		0.02184
		(0.04407)		(0.03966)
Poor (1=yes; 0=no)		-0.10742*		-0.06401
		(0.05739)		(0.05054)
Wealth index score		0.00069		0.00093**
		(0.00047)		(0.00044)
Road density index		0.08424		0.27776***
		(0.08342)		(0.05941)
Hill zone (0/1)		0.15786**		0.24182***
		(0.06443)		(0.05912)
Mountain zone (0/1)		0.08149		0.29782***
		(0.09627)		(0.08392)
Food deficit district, 1, otherwise 0		-0.24606***		-0.12419***
		(0.04179)		(0.03576)
Altitude (masl, via GPS)		-0.00016***		0.00018***
		(0.00005)		(0.00005)
Constant	-2.89459***	-0.60624	-1.71372***	0.07269
	(0.17966)	(0.43871)	(0.16513)	(0.41345)
Observations	4,037	4,037	4,037	4,037
R-squared	0.03876	0.28854	0.01632	0.13496

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices and road density used for HAZ model are observed in the child born year while prices and road density used for WHZ model are observed in the lagged survey years.

Since the Maoist war ceased in 2006, children born before and after 2006 may have a differential effect of the price increase on child nutrition outcomes. Therefore we performed separate analysis for the children surveyed in 2006 and 2011 (Table 3). For children surveyed in 2006, we find the significant and negative influence of rise of wheat flour price on HAZ and milk price on WHZ. The increase of wheat flour prices by one rupees is correlated with the decrease of 0.01 of WHZ. For children surveyed in 2011, we find the negative association between sugar prices and HAZ at less than 5% level of significance. Increase in the price of wheat flour was statistically correlated with the improved WHZ in 2011 at less than 10% level of significance.

Table 3: Effect of food prices on child nutrition outcomes (model separately estimated for each surveyed years)

	2006		2011	
VARIABLES	Model 1A (HAZ)	Model 1B (WHZ)	Model 2A (HAZ)	Model 2B (WHZ)
Price of Animal Ghee in Rs/Kg	-0.0007	0.0001	0.0002	0.0003
	(0.0006)	(0.0006)	(0.0008)	(0.0010)
Price of Milk in Rs/litre year	0.0089	-0.0151**	-0.0134*	0.0060
	(0.0067)	(0.0060)	(0.0072)	(0.0082)
Price of Coarse Rice in Rs/Kg	0.0048	-0.0074	0.0092	-0.0025
	(0.0089)	(0.0109)	(0.0110)	(0.0120)
Price of Sugar in Rs/Kg	0.0041	-0.0066	0.0072	-0.0300*
	(0.0082)	(0.0124)	(0.0077)	(0.0154)
Price of Soybean in Rs/Kg	-0.0016	-0.0040	0.0038	-0.0025
	(0.0047)	(0.0045)	(0.0042)	(0.0055)
Price of Wheat Flour in Rs/Kg	-0.0144**	0.0068	-0.0086	0.0313*
	(0.0073)	(0.0068)	(0.0076)	(0.0179)
Constant	-0.5757	-0.4261	-1.2559	0.7101
	(0.5403)	(0.4907)	(0.8533)	(0.9620)
Observations	2,765	2,765	1,272	1,272
R-squared	0.2976	0.1568	0.3053	0.1307

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices used for HAZ model are observed in the child born year while prices used for WHZ model are observed in the lagged survey years. All control and explanatory variables used in Table 2 were used in the model estimation.

The first 1000 days of a child's life (roughly between conception and age 2) is considered a critical window for nutrition. Children poorly nourished during this period will have life long consequences such as mental retardation and lower immunity power. We separately assess the correlations between food prices and child nutrition outcomes for children before and after the first 1000 days of life (Table 4).

Table 4: Effect of food prices on child nutrition outcomes (model separately estimated for children below and above first 1000 days of their growth period)

VARIABLES	Below 1000 days		Above 1000 days	
	Model 1A (HAZ)	Model 1B (WHZ)	Model 2A (HAZ)	Model 2B (WHZ)
Price of Animal Ghee in Rs/Kg	-0.0003	0.0001	-0.0008	0.0003
	(0.0006)	(0.0006)	(0.0007)	(0.0006)
Price of Milk in Rs/litre year	-0.0123*	-0.0183***	0.0100	0.0046
	(0.0065)	(0.0059)	(0.0073)	(0.0059)
Price of Coarse Rice in Rs/Kg	0.0127	0.0069	-0.0082	0.0154*
	(0.0099)	(0.0089)	(0.0103)	(0.0086)
Price of Sugar in Rs/Kg	0.0022	-0.0276**	0.0163*	-0.0346***
	(0.0076)	(0.0112)	(0.0097)	(0.0098)
Price of Soybean in Rs/Kg	0.0013	-0.0042	0.0043	0.0003
	(0.0044)	(0.0045)	(0.0048)	(0.0041)
Price of Wheat Flour in Rs/Kg	-0.0129	0.0178**	-0.0111	-0.0014
	(0.0079)	(0.0082)	(0.0069)	(0.0078)
Constant	-1.1672*	0.5027	-1.2220	-0.2113
	(0.6056)	(0.5680)	(1.2724)	(1.0814)
Observations	2,276	2,276	1,761	1,761
R-squared	0.3183	0.1465	0.1807	0.1762

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices used for HAZ model are observed in the child born year while prices used for WHZ model are observed in the lagged survey years. All control and explanatory variables used in Table 2 were used in the model estimation.

For children during the first 1000 days, an increase in milk price was found to be negatively and significantly associated with the HAZ and WHZ. A one-rupee increase in milk price is correlated with decreases of 0.01 and 0.02 in HAZ and WHZ. Sugar price matters for WHZ. A one-rupee increase in the sugar price is associated with a 0.03 point decrease in WHZ. However, the wheat flour price was found to be positively correlated with WHZ. For children observed after their first 1000 days, the sugar price was found to be positively associated with HAZ and negatively associated with WHZ.

Table 5 presents results regarding food prices in separate samples for household landholdings of less and greater than 0.8 ha. For households holding greater than 0.8 ha, we did not find statistically significant associations between food prices on child nutrition outcomes. However for households owning less than 0.8 ha of land, we find negative and statistically significant correlations between wheat flour prices and HAZ. In the case of short-term nutrition outcomes (WHZ), we find positive correlations with wheat flour prices and negative correlations with sugar prices. A one-rupee increase in the sugar price is associated with a 0.03 point decrease in WHZ. Similarly a one-rupee increase in the wheat price is associated with a 0.012 point increase in WHZ.

Table 6 presents the results for poor and non-poor households. Our results show that for poor households, food price matters for WHZ. Although the rise in wheat price was found to improve WHZ, the rise in milk, sugar and soybean prices reduces WHZ. Increase in price of milk, sugar and soybean by additional rupee was associated with the decrease of WHZ by 0.01, 0.03, and 0.9, respectively. For rich households, increase in soybean price by additional rupee was found to improve WHZ by 0.01.

Table 5: Effect of food prices on child nutrition outcomes (model separately estimated for households with above and less than 0.8 ha of agricultural land)

	<0.8 ha		>=0.8 ha	
VARIABLES	Model 1A (HAZ)	Model 1B (WHZ)	Model 2A (HAZ)	Model 2B (WHZ)
Price of Animal Ghee in Rs/Kg	-0.0007	0.0004	-0.0004	-0.0005
	(0.0005)	(0.0005)	(0.0010)	(0.0010)
Price of Milk in Rs/litre year	-0.0059	-0.0058	0.0220	-0.0157
	(0.0049)	(0.0047)	(0.0158)	(0.0115)
Price of Coarse Rice in Rs/Kg	0.0058	0.0068	0.0046	0.0068
	(0.0071)	(0.0072)	(0.0181)	(0.0138)
Price of Sugar in Rs/Kg	0.0043	-0.0331***	-0.0113	-0.0008
	(0.0053)	(0.0084)	(0.0148)	(0.0186)
Price of Soybean in Rs/Kg	0.0026	-0.0007	-0.0049	-0.0140
	(0.0031)	(0.0033)	(0.0095)	(0.0090)
Price of Wheat Flour in Rs/Kg	-0.0094*	0.0119*	-0.0026	0.0051
	(0.0054)	(0.0066)	(0.0123)	(0.0127)
Constant	-0.4708	0.0406	-2.1487*	0.5440
	(0.4760)	(0.4550)	(1.2118)	(1.1404)
Observations	3,436	3,436	601	601
R-squared	0.2874	0.1339	0.3596	0.2254

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices used for HAZ model are observed in the child born year while prices used for WHZ model are observed in the lagged survey years. All control and explanatory variables used in Table 2 were used in the model estimation.

We expect that a rise in food prices will have different implications on child nutrition outcomes for children from food surplus and deficit districts. Generally speaking, higher food prices compromise food consumption by households that are net-buyers (i.e. those who consume more than they produce, and must therefore rely on purchases). At the same time, higher food prices may benefit households that are net-sellers (i.e. those who produce more than they consume, and therefore generate income through sales). Table 7 presents results estimated separately for the food surplus and food deficit districts. For food-deficit districts, we find a negative and significant association between the price of animal ghee and HAZ while we find a positive and significant association between the price of soybean and HAZ. For WHZ, we find negative correlations with coarse rice and sugar prices and a positive correlation with wheat flour prices. For food-surplus districts, we find positive association between the coarse rice prices and WHZ suggesting a potentially beneficial effect from higher coarse rice prices on short-term child nutrition outcomes in net-selling areas. A one-rupee rise in the coarse rice price in food deficit districts is associated with a 0.03 point decrease in the average WHZ. In contrast, a one-rupee rise in the coarse rice price in a food surplus districts is associated with a 0.02 point increase in average WHZ.

Table 6: Effect of food prices on child nutrition outcomes (model separately estimated for poor and non-poor households)

	Poor		Non Poor	
VARIABLES	Model 1A (HAZ)	Model 1B (WHZ)	Model 2A (HAZ)	Model 2B (WHZ)
Price of Animal Ghee in Rs/Kg	-0.0010	0.0013**	0.0004	-0.0010
	(0.0006)	(0.0006)	(0.0006)	(0.0007)
Price of Milk in Rs/litre year	-0.0057	-0.0131**	0.0012	0.0019
	(0.0062)	(0.0055)	(0.0080)	(0.0075)
Price of Coarse Rice in Rs/Kg	0.0077	0.0104	-0.0017	0.0040
	(0.0087)	(0.0079)	(0.0115)	(0.0123)
Price of Sugar in Rs/Kg	-0.0018	-0.0340***	0.0044	-0.0011
	(0.0076)	(0.0094)	(0.0070)	(0.0145)
Price of Soybean in Rs/Kg	0.0010	-0.0090**	-0.0010	0.0144**
	(0.0043)	(0.0039)	(0.0042)	(0.0059)
Price of Wheat Flour in Rs/Kg	-0.0092	0.0149**	-0.0101	-0.0104
	(0.0064)	(0.0074)	(0.0081)	(0.0111)
Constant	-0.4440	-0.8602	-1.3125**	-1.2359*
	(0.7066)	(0.5974)	(0.6186)	(0.7115)
Observations	1,910	1,910	2,127	2,127
R-squared	0.2324	0.1418	0.2729	0.1477

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices used for HAZ model are observed in the child born year while prices used for WHZ model are observed in the lagged survey years. All control and explanatory variables used in Table 2 were used in the model estimation.

Table 7: Effect of food prices on child nutrition outcomes (model separately estimated for food deficit and surplus districts)

VARIABLES	Food Deficit		Food Surplus	
	Model 1A (HAZ)	Model 1B (WHZ)	Model 2A (HAZ)	Model 2B (WHZ)
Price of Animal Ghee in Rs/Kg	-0.0017*	0.0001	-0.0001	-0.0003
	(0.0009)	(0.0011)	(0.0006)	(0.0006)
Price of Milk in Rs/litre year	-0.0099	-0.0116	0.0004	-0.0032
	(0.0078)	(0.0076)	(0.0070)	(0.0067)
Price of Coarse Rice in Rs/Kg	0.0050	-0.0304*	-0.0101	0.0189**
	(0.0126)	(0.0181)	(0.0084)	(0.0080)
Price of Sugar in Rs/Kg	-0.0025	-0.0264*	0.0045	-0.0205
	(0.0084)	(0.0143)	(0.0067)	(0.0125)
Price of Soybean in Rs/Kg	0.0149**	0.0038	-0.0033	0.0002
	(0.0066)	(0.0067)	(0.0044)	(0.0050)
Price of Wheat Flour in Rs/Kg	0.0144	0.0324**	-0.0011	-0.0017
	(0.0121)	(0.0142)	(0.0063)	(0.0087)
Constant	-0.7783	0.4026	-0.6805	-0.6886
	(0.7038)	(0.7270)	(0.5670)	(0.5695)
Observations	1,710	1,710	2,327	2,327
R-squared	0.3146	0.1765	0.2791	0.1334

*** Indicates p<0.01, ** p<0.05, * p<0.1. Prices used for HAZ model are observed in the child born year while prices used for WHZ model are observed in the lagged survey years. All control and explanatory variables used in Table 2 were used in the model estimation.

7. Conclusion

We assessed the effects of food prices on child nutrition outcomes in Nepal. Six food commodities (coarse rice, wheat flour, soybean, milk, ghee and sugar) that are considered to be important for child food and nutrition are used for the analysis. Since we have fairly complete price series from 34 districts, we paired child nutrition data with the price data from the same districts. In total we used information from 4,037 children surveyed in 2006 and 2011. We conducted analysis at the child level.

We estimated series of models using ordinary least square regression technique. We estimated the parsimonious model with just including the price variables of interest and then later estimated the full model controlling for child, mother, household, and district specific characteristics. We also estimated separate model based on the survey year, poor and non-poor households, children before and after the first 1000 days of their growth, household holding below/above 0.8 hectare of land, and food surplus and deficit districts. Doing so, we broaden our understanding on the differential effect of food prices on child nutrition.

Overall, the evidence of food price increases on child nutrition outcomes is mixed. We find a negative association between wheat prices and HAZ and a positive association between wheat prices and WHZ in most of the regressions. Similarly we find the negative a negative association between sugar prices and WHZ. Only in case of milk do we find a consistently negative association with both HAZ and WHZ across models. A one-rupee increase in the price of coarse rice is associated with a decrease in average WHZ by 0.03 in food deficit districts. A one-rupee increase in the price of coarse rice is associated with an increase in average WHZ by 0.02 in food surplus districts.

What policy implications emerge from this study? Clearly we find robust evidence of negative correlations between milk prices and child nutrition outcomes. Since milk is one of the major food items in the diets of children, we suggest strict attention to milk prices in the marketplace. The price of coarse rice price matters for short-term child nutrition outcomes in food deficit districts. Therefore, frequent increases in the price of coarse rice should be discouraged in such districts. Market interventions that are likely to reduce coarse rice prices can be expected to improve child nutrition outcomes in food deficit districts.

This study has some limitations. First, our data come from only 34 districts. As a result, we need to be cautious about interpreting our findings at the national level. Second, we were not able to estimate the causal impact of food prices on child nutrition outcomes. Our results should be understood as providing evidence on association and correlation, not causality. Third, our food price data were observed at the district level. Analysis based on food price data observed at the village level may provide more precise estimates of the relationship between food prices and child nutrition outcomes.

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