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Food price inflation and child stunting in South Asia: Evidence from panel data

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ABSTRACT: Child stunting reflects chronic nutritional deprivation, while food-price increases can reduce household purchasing power and diet quality. This ecological panel study examined whether sustained food price inflation was associated with modeled stunting prevalence among children younger than five years in seven South Asian countries during 2003-2023. Annual food inflation was calculated as the percentage change in annual mean national Food Consumer Price Index from FAOSTAT. The primary exposure was the mean of current, one-year-lagged, and two-year-lagged inflation. UNICEF-WHO-World Bank Joint Child Malnutrition Estimates were linked to GDP per capita, current health expenditure, sanitation, and urbanization. Two-way fixed-effects models used Driscoll-Kraay standard errors because residual diagnostics indicated serial correlation and cross-sectional dependence. The primary model included 147 country-year observations. A one-percentage-point increase in three-year average food inflation was associated with a 0.120-percentage-point lower stunting prevalence (95% CI -0.245 to 0.005; $p=0.058$), which did not support the hypothesized positive association. Contemporaneous and one-year-lagged inflation were not statistically distinguishable from zero, whereas the two-year-lagged estimate was negative and narrowly excluded zero. Given the secondary nature of these exposure-window analyses, the isolated two-year-lagged result should be interpreted cautiously. The negative direction persisted in leave-one-country-out analyses, but precision and statistical significance varied. These findings do not support a positive country-level association between sustained food inflation and modeled annual stunting prevalence. They should not be interpreted causally; strong secular improvements in stunting, limited between-year outcome variation, modeled outcomes, and residual confounding may obscure household-level harms documented elsewhere.

1. INTRODUCTION

Child stunting, defined as height-for-age below two standard deviations from the World Health Organization Child Growth Standards median, reflects cumulative constraints on growth. It is associated with impaired development, lower educational attainment, reduced adult productivity, and elevated health risks (Victora et al., 2008; Black et al., 2013). The 2025 Joint Child Malnutrition Estimates provide modeled country trends for stunting from 2000 to 2024 and show that global progress remains insufficient to meet the 2030 target (UNICEF, World Health Organization and World Bank Group, 2025). South Asia continues to carry a substantial burden despite long-run improvement.

Nutrition is shaped by immediate dietary intake and disease as well as household resources, caregiving, public services, sanitation, and health systems. Economic conditions therefore matter for child growth. When food prices rise faster than income, households face a decline in real purchasing power. Poor households, which devote a larger share of expenditure to food, may reduce quantities, substitute toward less costly and less nutrient-dense foods, or defer healthcare spending (Brinkman et al., 2010; Headey and Ruel, 2023).

Recent micro-level studies provide a strong reason to examine food inflation. Headey and Ruel (2023) linked food prices to 1.27 million children in 44 low- and middle-income countries and reported higher risks of wasting and later stunting following early-life exposure. Woldemichael et al. (2022) found adverse early-life effects in Ethiopia. A Bangladesh study also identified an association between food inflation and stunting, although its negative coefficient illustrates that sign and interpretation can depend on data construction and modeling choices (Sadiqueen et al., 2024).

Existing evidence has largely examined food-price exposure at the household or individual level, where variation in local prices, household resources, and child-level outcomes can be directly observed. Country-level panel evidence addresses a different question: whether within-country changes in national food-price inflation correspond with changes in national stunting prevalence after accounting for stable country characteristics and common temporal shocks. Such analyses are particularly limited in South Asia, despite the region's persistent burden of childhood stunting and recurrent food-price instability. Examining cumulative and lagged national inflation may therefore provide complementary evidence on whether macroeconomic food-price conditions are reflected in population-level nutrition trends.

This study examined whether current and preceding national food-price inflation were associated with modeled stunting prevalence among children younger than five years in Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The primary exposure was cumulative food-price inflation, operationalized as the mean annual food inflation in years t , $t-1$, and $t-2$. It was hypothesized that higher three-year average food inflation would be associated with higher stunting prevalence after adjustment for GDP per capita, health expenditure, sanitation, and urbanization. Associations with contemporaneous, one-year-lagged, and two-year-lagged inflation were examined as secondary exposure specifications.

2. MATERIALS AND METHODS

2.1 Study design and setting

This observational longitudinal ecological study used country-year observations. Seven South Asian countries were audited before inclusion. All seven had adequate overlap for stunting, food prices, GDP per capita, health expenditure, sanitation, and urbanization. Afghanistan was not part of the selected country set and was not assessed. The initially observed period was 2000-2024. The final primary period was 2003-2023 because the three-year exposure required two lag years and the selected health-expenditure indicator was unavailable for 2024.

2.2 Data sources and outcome

Stunting prevalence was obtained from World Development Indicators code SH.STA.STNT.ME.ZS, sourced from the UNICEF-WHO-World Bank Joint Child Malnutrition Estimates. These are modeled annual estimates, not direct annual survey observations. The model combines available primary survey data and covariates to produce comparable annual country estimates. This distinction applies to all outcome values in the analysis.

Food CPI was obtained from the FAOSTAT Consumer Price Indices database (Food and Agriculture Organization of the United Nations, 2026). The source contained monthly Food CPI values indexed to 2015=100 and monthly food-inflation values. Annual Food CPI was the mean of available monthly index values, requiring at least ten months; all retained country-years had sufficient observations. Annual food inflation was calculated as $100 \times (\text{annual mean CPI}_t / \text{annual mean CPI}_{t-1} - 1)$. This calculation was used because the downloaded domain did not contain a separate annual national food-inflation row.

2.3 Exposure and covariates

The primary exposure was the arithmetic mean of annual food inflation in year t and years $t-1$ and $t-2$. Secondary exposures were contemporaneous inflation and one- and two-year lags. The cumulative window was selected to reflect the chronic nature of linear growth and the relevance of nutritional exposures during pregnancy and early childhood.

GDP per capita was measured in constant 2021 purchasing-power-parity international dollars (NY.GDP.PCAP.PP.KD) and log transformed. Current health expenditure was measured as a percentage of GDP (SH.XPD.CHEX.GD.ZS). Sanitation was the percentage of the population using at least basic sanitation services (SH.STA.BASS.ZS), and urbanization was the urban share of total population (SP.URB.TOTL.IN.ZS). Data were downloaded through the World Bank (World Bank, 2026); health-expenditure values originate from the WHO Global Health Expenditure Database (World Health Organization, 2026).

Table 1. Variables, definitions, units, sources, and expected relationships.

Variable	Definition	Unit	Source	Expected association
Stunting	Height-for-age below -2 SD, children <5	%	JME via WDI	Outcome
Three-year food inflation	Mean inflation in t, t-1, t-2	percentage points	FAOSTAT, calculated	Positive
Log GDP per capita	PPP, constant 2021 international \$	log units	WDI	Negative
Health expenditure	Current health expenditure	% GDP	WHO GHED via WDI	Negative
Sanitation	At least basic sanitation	% population	JMP via WDI	Negative
Urbanization	Urban population	% total	WDI	Ambiguous

2.4 Data management

Country names and ISO3 codes were harmonized. A complete country-year grid was built for 2000-2024. Duplicate keys, year types, units, impossible values, and merge failures were checked. No missing values were imputed or extrapolated. Lags were calculated within countries after chronological sorting. The clean panel contained 175 possible country-years; the primary complete-case panel contained 147 observations covering seven countries and 21 years.

2.5 Statistical analysis

Descriptive statistics and Pearson correlations summarized the panel. The primary estimator was ordinary least squares with country and year fixed effects. Country effects absorb time-invariant geography, institutional structure, long-run dietary patterns, and baseline development. Year effects absorb common global price episodes, recessions, the COVID-19 period, and other shared shocks. The full model adjusted for log GDP per capita, health expenditure, sanitation, and urbanization.

Driscoll-Kraay standard errors with bandwidth three were used for primary inference because there were only seven countries and diagnostics indicated both positive serial correlation and cross-sectional dependence (Driscoll and Kraay, 1998). This estimator is heteroskedasticity consistent and permits temporal and spatial dependence when the time dimension is moderate. Heteroskedasticity-consistent and country-clustered standard errors were reported only as sensitivity analyses because conventional clustered inference can be unreliable with very few clusters (Cameron and Miller, 2015).

Secondary models replaced the three-year average with contemporaneous, one-year-lagged, or two-year-lagged inflation. Robustness analyses included a reduced-control sequence, first differences with year effects, exclusion of observations with Cook's distance above 4/N, and leave-one-country-out re-estimation. Statistical tests were two-sided. Associations were not interpreted as causal.

2.6 Ethical considerations

This study used publicly available, aggregated country-level secondary data and did not involve direct interaction with human participants or access to individually identifiable information. Institutional ethical approval and individual informed consent were therefore not required.

3. RESULTS AND DISCUSSION

3.1 Country inclusion and data coverage

All seven selected countries were retained. Stunting, Food CPI, GDP, sanitation, and urbanization were available for 2000-2024. Health expenditure was available for 2000-2023. After construction of a complete three-year inflation window, the

common primary period was 2003-2023. Each country contributed 21 observations, yielding a balanced primary analytical panel of 147 country-years (Table 2).

Table 2. Country and data coverage.

Country	Source availability	Final years	N	Decision
Bangladesh	2000-2024; health expenditure to 2023	2003-2023	21	Included
Bhutan	2000-2024; health expenditure to 2023	2003-2023	21	Included
India	2000-2024; health expenditure to 2023	2003-2023	21	Included
Maldives	2000-2024; health expenditure to 2023	2003-2023	21	Included
Nepal	2000-2024; health expenditure to 2023	2003-2023	21	Included
Pakistan	2000-2024; health expenditure to 2023	2003-2023	21	Included
Sri Lanka	2000-2024; health expenditure to 2023	2003-2023	21	Included

3.2 Descriptive characteristics and trends

Mean modeled stunting prevalence was 31.4% (SD 12.0; range 10.2-52.6). Mean three-year food inflation was 7.9% (SD 4.8). Figure 1 shows broad declines in modeled stunting in every country. Figure 2 shows larger year-to-year volatility in food inflation, with pronounced country-specific peaks. These distinct temporal properties are important: slow modeled outcome trends provide limited information about short-lived price shocks.

Table 3. Descriptive statistics for the analytical panel.

Variable	N	Mean	SD	Median	Minimum	Maximum
Stunting_pct	147	31.439	11.986	33.300	10.200	52.600
Food_Inflation_pct	147	8.347	7.229	7.459	-6.078	60.357
Food_Inflation_L1	147	7.998	6.863	7.323	-6.078	60.357
Food_Inflation_L2	147	7.426	5.279	7.166	-6.078	28.532
Food_Inflation_3yrAvg	147	7.924	4.783	7.258	-0.140	27.911
ln_GDP_per_capita	147	8.867	0.603	8.816	7.800	10.014
Health_Expenditure	147	4.142	2.098	3.596	1.962	11.471
Sanitation_pct	147	64.186	20.911	64.144	22.429	99.318
Urbanization_pct	147	35.278	12.429	34.093	14.726	66.543

Table 4. Pearson correlation matrix.

Variable	Stuntin g_pct	Food_Inflation _3yrAvg	Food_Inflati on_pct	ln_GDP_per _capita	Health_Expe nditure	Sanitatio n_pct	Urbanizati on_pct
Stunting_pct	1.00	-0.09	-0.04	-0.88	-0.51	-0.95	0.21

Food_Inflation_3yrAvg	-0.09	1.00	0.75	-0.05	-0.13	0.07	-0.10
Food_Inflation_pct	-0.04	0.75	1.00	-0.05	-0.10	0.04	-0.09
ln_GDP_per_capita	-0.88	-0.05	-0.05	1.00	0.58	0.89	-0.29
Health_Expenditure	-0.51	-0.13	-0.10	0.58	1.00	0.56	0.27
Sanitation_pct	-0.95	0.07	0.04	0.89	0.56	1.00	-0.13
Urbanization_pct	0.21	-0.10	-0.09	-0.29	0.27	-0.13	1.00

These pooled correlations largely reflect cross-country differences and common secular development trends and should not be interpreted as the within-country relationships estimated by the fixed-effects models.

Figure 1. Modeled prevalence of stunting among children younger than five years by South Asian country, 2000-2024. Values are UNICEF-WHO-World Bank Joint Child Malnutrition Estimates modeled annual estimates.

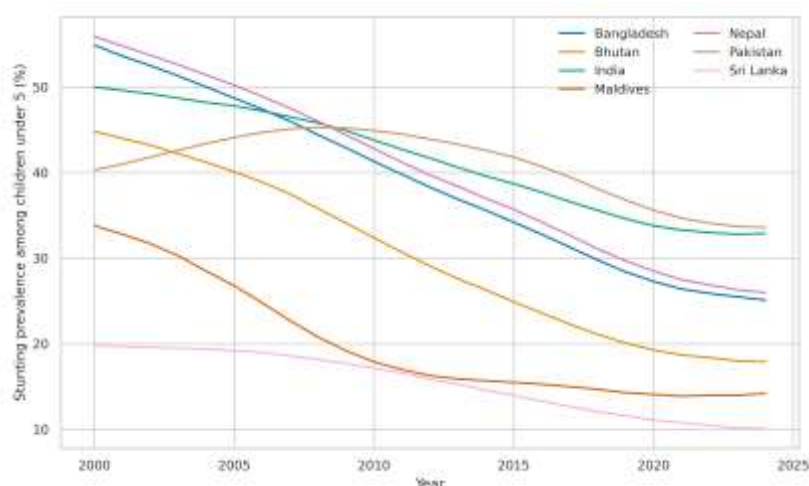
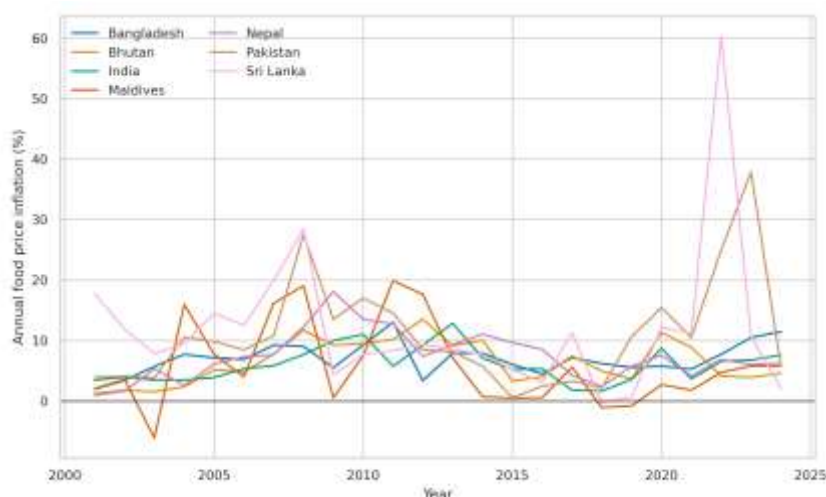


Figure 2. Annual food price inflation by South Asian country, 2001-2024. Inflation is the annual percentage change in annual mean monthly national Food CPI.



3.3 Primary association

In the exposure-only two-way fixed-effects model, the coefficient for three-year food inflation was -0.138 percentage points (95% CI -0.471 to 0.195; $p=0.398$). After log GDP per capita was added, it was -0.152 (95% CI -0.392 to 0.089; $p=0.203$). In the primary full model, a one-percentage-point increase in three-year average food inflation was associated with a -0.120-percentage-point difference in stunting (95% CI -0.245 to 0.005; $p=0.058$). The estimate was negative and its confidence interval included zero. The primary hypothesis of a positive association between three-year average food inflation and stunting was therefore not supported.

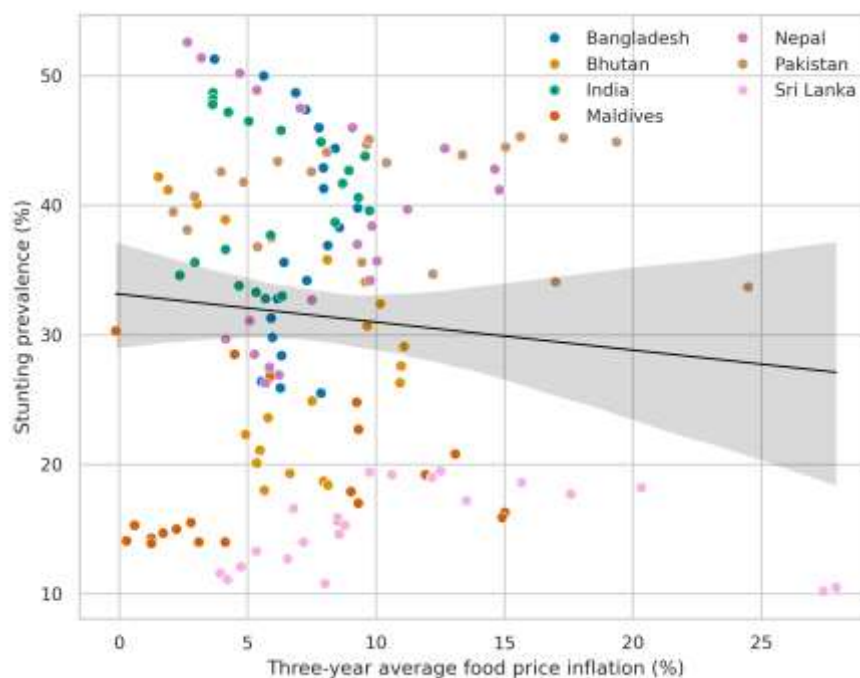
The negative ecological coefficient does not imply that food inflation improves child nutrition. A likely explanation is residual confounding by development trajectories and mismatched temporal resolution. Modeled stunting estimates decline smoothly, whereas national food inflation changes rapidly. Country and year effects identify the coefficient from deviations around these trends, not from the large cross-country differences in average stunting. Reverse timing, policy responses, food production, social protection, and unmeasured income distribution may also affect national aggregates.

Table 5. Three-year food-inflation fixed-effects regressions.

Model	Coefficient	SE	95% CI	p	N	Country FE	Year FE
Model 1	-0.138	0.160	-0.471 to 0.195	0.398	147	Yes	Yes
Model 2	-0.152	0.115	-0.392 to 0.089	0.203	147	Yes	Yes
Model 3 primary	-0.120	0.060	-0.245 to 0.005	0.058	147	Yes	Yes

Notes: Coefficients are percentage-point differences in modeled stunting prevalence per one-percentage-point difference in three-year average inflation. All models use Driscoll-Kraay standard errors with bandwidth three.

Figure 3. Three-year average food price inflation and modeled child stunting in the analytical panel, 2003–2023. Points are country-years; the line is an unadjusted pooled linear fit and is descriptive only.



3.4 Secondary exposure-window analyses

Secondary analyses examined whether the estimated association differed when food inflation was specified contemporaneously or with one- and two-year lags. Contemporaneous: $\beta = -0.028$, 95% CI -0.106 to 0.051, $p = 0.471$; 1-year lag: $\beta = -0.052$, 95% CI -0.134 to 0.031, $p = 0.206$; 2-year lag: $\beta = -0.135$, 95% CI -0.270 to -0.000, $p = 0.049$. The secondary exposure-window analyses likewise did not support the hypothesized positive association. Contemporaneous and one-year-lagged inflation were not statistically distinguishable from zero, while the two-year-lagged estimate was negative with a confidence interval that narrowly excluded zero. Given the secondary nature of this specification and the examination of multiple exposure windows, this isolated result should be interpreted cautiously and was not consistently supported across the broader sensitivity analyses.

Table 6. Secondary food-inflation exposure windows.

Exposure	Coefficient	SE	95% CI	p	N
Contemporaneous	-0.028	0.038	-0.106 to 0.051	0.471	161
1-year lag	-0.052	0.040	-0.134 to 0.031	0.206	154
2-year lag	-0.135	0.065	-0.270 to -0.000	0.049	147

Notes: These secondary models include the full control set plus country and year fixed effects and use Driscoll-Kraay standard errors with bandwidth three. The primary three-year-average specification is reported in Table 5.

3.5 Diagnostics and robustness

The Durbin-Watson statistic was 0.328, indicating positive serial correlation. The Pesaran CD statistic was -3.301 ($p = 0.001$), indicating cross-sectional dependence. The heteroskedasticity auxiliary test was not significant ($p = 0.261$). VIFs ranged from 1.12 to 7.30, with log GDP per capita having the highest value, indicating moderate collinearity among development-related covariates but not extreme instability.

The primary coefficient was unchanged by the covariance estimator, but its uncertainty was smaller with HC1 and conventional country clustering than with Driscoll-Kraay. The first-difference coefficient was -0.030 (95% CI -0.065 to 0.004; $p = 0.083$). Excluding observations above the Cook's-distance rule produced a more negative estimate, showing sensitivity to influential country-years. Leave-one-country-out coefficients remained negative (-0.166 to -0.060), but p -values ranged from 0.001 to 0.499. No omission reversed the sign, although precision depended on composition.

Table 7. Robustness analyses.

Specification	Coefficient	SE	95% CI	p	N
Primary HC1	-0.120	0.048	-0.215 to -0.025	0.014	147
Primary CLUSTER	-0.120	0.039	-0.197 to -0.043	0.003	147
Primary DK	-0.120	0.060	-0.245 to 0.005	0.058	147
First difference	-0.030	0.016	-0.065 to 0.004	0.083	140
Exclude Cook's $D > 4/N$	-0.167	0.034	-0.238 to -0.096	0.000	134

Notes: The covariance estimator is identified in the specification label. High R-squared values in fixed-effects models largely reflect country effects, year effects, and secular outcome trends.

3.6 Interpretation and policy implications

The present findings differ from several micro-level studies reporting adverse nutritional consequences of food-price increases (Headey and Ruel, 2023; Woldemichael et al., 2022). This difference does not necessarily indicate inconsistency between the two bodies of evidence because the estimands are different. Household-level studies evaluate whether children

exposed to higher food prices experience poorer nutritional outcomes, often using local price variation and individual anthropometric data. In contrast, the present analysis evaluates whether changes in national food inflation correspond with changes in modeled national stunting prevalence. The latter outcome changes gradually and may be relatively insensitive to short-term economic shocks. Consequently, harmful effects concentrated among poorer households may coexist with weak or null associations at the national aggregate level. Aggregation can also combine net food purchasers with agricultural producers who may benefit from higher output prices, while social protection, policy responses, and residual confounding may further weaken or alter the observed national association.

The null-to-negative country-level result should not be used to dismiss food affordability policy. Governments should continue to monitor high-frequency food prices, protect maternal and child diets through responsive transfers or nutritious-food support, index benefits during inflationary episodes, and maintain sanitation and primary healthcare. Evaluation should link local price series to repeated household anthropometry and dietary data, with explicit timing from pregnancy through the first 1,000 days.

3.7 Strengths and limitations

Strengths include a clearly defined cumulative exposure, transparent inclusion of all audited countries, preservation of raw source extracts, reproducible construction of annual inflation, two-way fixed effects, dependence-robust inference, and multiple sensitivity analyses.

The study has important limitations. First, the ecological design cannot identify individual exposure or infer individual-level effects. Second, stunting values are modeled annual estimates based on intermittent surveys; they are not annual survey measurements and may smooth short-run changes. Third, residual confounding and endogeneity remain possible despite fixed effects. Fourth, seven countries limit cluster-based inference and external validity. Fifth, annual national Food CPI does not measure local price exposure, household purchasing power, diet substitution, or whether households are net food buyers or sellers. Finally, strong trends and high serial dependence reduce independent variation; first-difference and influence analyses showed that magnitude and precision were not fully stable.

4. CONCLUSION

Across seven South Asian countries from 2003 to 2023, higher three-year average national food-price inflation was not associated with higher modeled annual stunting prevalence after adjustment for country and year fixed effects and selected socioeconomic covariates. The primary estimate was negative, but its confidence interval included zero, and the hypothesized positive association was not supported. These findings should not be interpreted as evidence that food inflation protects against childhood stunting. Rather, they suggest that national annual inflation and modeled stunting series may be too aggregated and temporally smooth to capture household-level nutritional effects. Future studies should link local food-price variation with repeated household-level anthropometry, dietary measures, and exposure timing across pregnancy and early childhood.

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