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# Animal sourced foods and child stunting

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# Introduction

**Why do we care about stunting?**

- Globally, 160 million children under the age of 5 are stunted
- Stunting in early life – a marker of poor nutrition – is linked to adverse physical, cognitive & economic development
- Most stunting manifests in the first 1000 days of life (Victora, et al., 2009), especially over ages 6-24 months

**Why do kids start to fall behind at ~6 months?**

- Poor diets: Rapidly increasing nutrient requirements no longer met by breastmilk, poor feeding frequency, inadequately diversified diet
- Infection: Infant's weak immune system is highly vulnerable to increased exposure to pathogens ... diarrhea, EED, etc

# Introduction

**Surprisingly, dietary determinants of stunting somewhat neglected**

- Diets are elusive: Individual "usual" diets are hard to measure
- Diets hard to experiment on: Surprisingly little evidence in LDCs
- Household surveys used to link dietary diversity indicators to stunting, but associations tend not to be robust

**For child growth, diversifying into ASFs may be especially crucial**

- Since 1974, protein deficiency concerns largely sidelined
- Yet ASF proteins contains essential amino acids that can't be synthesized within the body: seminal role in programming growth
- ASFs also dense in a wide range of micronutrients linked to growth
- Multiple ASFs preferable: e.g. dairy rich in calcium, but no iron

# Introduction

**Empirical evidence linking ASFs to child growth is varied**

- Handful of ASF interventions do find sizeable growth impacts
- Nutrition-sensitive livestock interventions also sometimes show signs of impact, but typically also use behavioral interventions
- Observational studies link growth to livestock ownership (East Africa)
- Historical studies link adult heights to ASF consumption patterns

**Weak evidence on constraints to ASF consumption among children**

- Economic studies focus on constraints to *household* consumption
- Sociological studies focus on cultural constraints (e.g. eggs in Africa)
- Nutrition interventions assume knowledge is the major constraint

# Research questions

**In light of these knowledge gaps, this paper offers three contributions**

1. **ASF consumption patterns:** Use DHS data on 112,553 children aged 6-23 months from 46 developing countries
2. **ASFs & stunting associations:** Use this dataset to estimate associations between dietary patterns and stunting; go beyond aggregated diversity metrics to look at specific food groups
3. **Constraints to ASF consumption:** We look at price, wealth and "knowledge" constraints to document the main factors driving ASF consumption patterns in poor countries

# Data

- Data on 112,553 children from 46 countries covered by the Demographic Health Surveys (DHS) between 2006 and 2014
- **Child diets**: Since mid 2000s DHS mothers asked which of 12 food groups their youngest child consumed in the past 24 hours.

**Table 1. Food groups listed in the DHS phases 5 & 6**

| Aggregated food groups in DDS (7 groups) | Disaggregated food groups (12 groups) |
|---|---|
| (1) Starchy staples | (1) Grains; (2) Roots/tubers |
| (2) Legumes/nuts | (3) Legumes/nuts |
| (3) Vitamin-A rich fruits/vegetables | (4) Vit-A rich fruits; (5) Vit-A rich vegetables |
| (4) Other fruits/vegetables | (6) other fruits (7) dark green leafy vegetables, (8) other vegetables |
| (5) Dairy | (7) Cow's milk; (8) Infant formula |
| (6) Eggs | (9) Eggs |
| (7) Flesh foods | (10) Meat/organs; (11) Fish |
| | (12) Fortified infant cereals |

# Data

- **Stunting:** height-for-age Z score < -2
- **ASF prices:** Use "calorie price ratios" (CPRs) from Headey et al's (2017) analysis of 2011 International Comparison program data
- CPR is the price of 1 calorie of cheapest food in a given food group relative to 1 calorie of cheapest staple cereal in each country

**Table 3. Classification of cereals & specific ASF products in ICP 2011 data**

| Food group | # products | Specific products used to construct minimum price |
|---|---|---|
| Cereals | 13 | Rice (5), bread products (5), maize flour, maize, tortilla |
| Cow's milk, fresh | 2 | Pasteurized fresh milk, unskimmed or low-fat |
| Cow's milk, long-life | 3 | Condensed milk, powdered milk, UHT |
| Meat, fresh | 20 | Whole chicken (2 ), chicken breast, chicken leg; Beef/veal (7 varieties), Lamb/mutton (4 varieties), Pork (4 varieties), Goat (1 variety); all unprocessed. |
| Chicken eggs, fresh | 2 | Large brown eggs, medium brown eggs |
| Fish, fresh | 5 | Fresh Carp, Mackerel or Tilapia; canned Sardines or canned Tuna |

# Methods

- **Descriptives:** unweighted consumption patterns by child age
- **Graphical evidence:**
- LPOLY graphs of stunting by age and ASF consumption by age;
- Stunting by age for ASF=1 and ASF=0 sub-samples;
- **Multivariate regressions:** pooled across country with survey fixed effects (averages of within-country variation), saturated with control variables (wealth, education, health services, WASH, etc)
- **Age disaggregation:** benefits of improved diets not instantaneous but cumulative, so expect larger effects for older kids (e.g. 18-23m)
- **Dietary disaggregation:** going to split sample into kids achieving or not achieving minimum dietary diversity
- **Problems**: Omitted variables bias, attenuation bias, imprecision…

# ASF consumption patterns

**Table 4. Stunting and dietary indicators by region, children 6-23 months of age**

| | Stunting (%) | Diet diversity 0-7 groups | Min. diet diversity (MDD) | At least 1 ASF | MDD=0 and 1+ ASFs | MDD=1 and 1+ ASFs |
|---|---|---|---|---|---|---|
| Latin America & Caribbean | 23.6% | 4.0 | 63.6% | 84.3% | 66.7% | 99.2% |
| North Africa & Western Asia | 25.8% | 2.9 | 37.0% | 76.6% | 81.2% | 99.4% |
| South, Central & South-East Asia | 37.1% | 2.3 | 21.1% | 57.9% | 59.7% | 96.7% |
| Western & Central Africa | 32.5% | 2.0 | 16.6% | 52.4% | 54.9% | 95.4% |
| Eastern & Southern Africa | 37.3% | 2.2 | 16.9% | 49.1% | 47.3% | 91.7% |
| All | 31.9% | 2.6 | 28.8% | 61.8% | 47.4% | 97.3% |

# ASF consumption patterns

**Table 5. Dietary patterns by region, children 6-23 months of age**

| | Latin America & Caribbean | North Africa & West Asia | South, Central & SE Asia | Western & Central Africa | Eastern & Southern Africa |
|---|---|---|---|---|---|
| | | | | | |
| Dairy | 57.5% | 64.9% | 38.4% | 20.8% | 18.7% |
| Eggs | 47.3% | 30.9% | 15.8% | 12.2% | 13.0% |
| Meat/fish | 56.3% | 30.9% | 23.2% | 39.7% | 33.6% |
| White/red meat* | 53.1% | 24.1% | 13.6% | 15.5% | 17.1% |
| Fish* | NA | 8.0% | 12.8% | 31.5% | 21.1% |

# ASFs and stunting

**Table 7. Least squares regressions of stunting against aggregated food groups for the full sample of children and MDD=0 children**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Age range (months) | 12-14 | 15-17 | 18-20 | 21-23 |
| Dietary range | Full | Full | Full | Full |
| | | | | |
| Any ASF | -0.010 | -0.005 | -0.037*** | -0.038*** |
| | | | | |
| | (5) | (6) | (7) | (8) |
| Age range (months) | 12-14 months | 15-17 months | 18-20 months | 21-23 months |
| Dietary range | MDD=0 | MDD=0 | MDD=0 | MDD=0 |
| | | | | |
| Any ASF | -0.010 | -0.007 | -0.040*** | -0.026** |
| | | | | |

- Fruits also have significant associations

# ASFs and stunting

**Table 8. Regressions of stunting against individual ASFs**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Age range (months) | 12-14 | 15-17 | 18-20 | 21-23 |
| | | | | |
| Dairy | 0.003 | 0.001 | -0.020** | -0.036*** |
| | | | | |
| Eggs | 0.004 | -0.004 | -0.007 | -0.017* |
| | | | | |
| Meat/fish | -0.017** | -0.026*** | -0.040*** | -0.026*** |
| | | | | |
| Observations | 20,454 | 18,997 | 17,761 | 15,912 |
| R-squared | 0.110 | 0.126 | 0.143 | 0.151 |

- Fish tends to have stronger associations than red/white meat
- Region-specific results more heterogenous
- Fruits also have significant associations

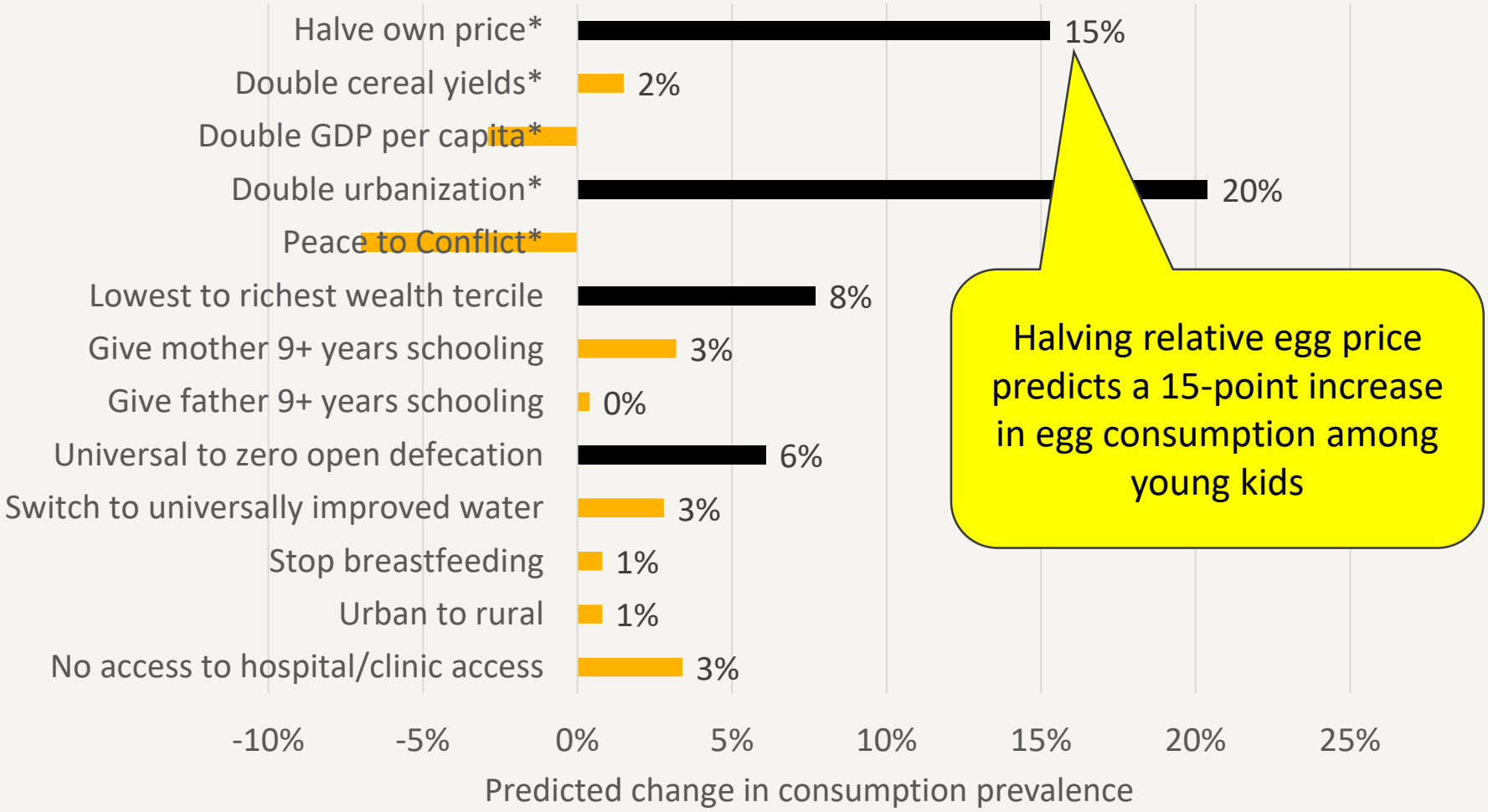
# High prices constrain dietary diversification

**Table 3. Cereal-relative calorie price ratios for various foods, by region**

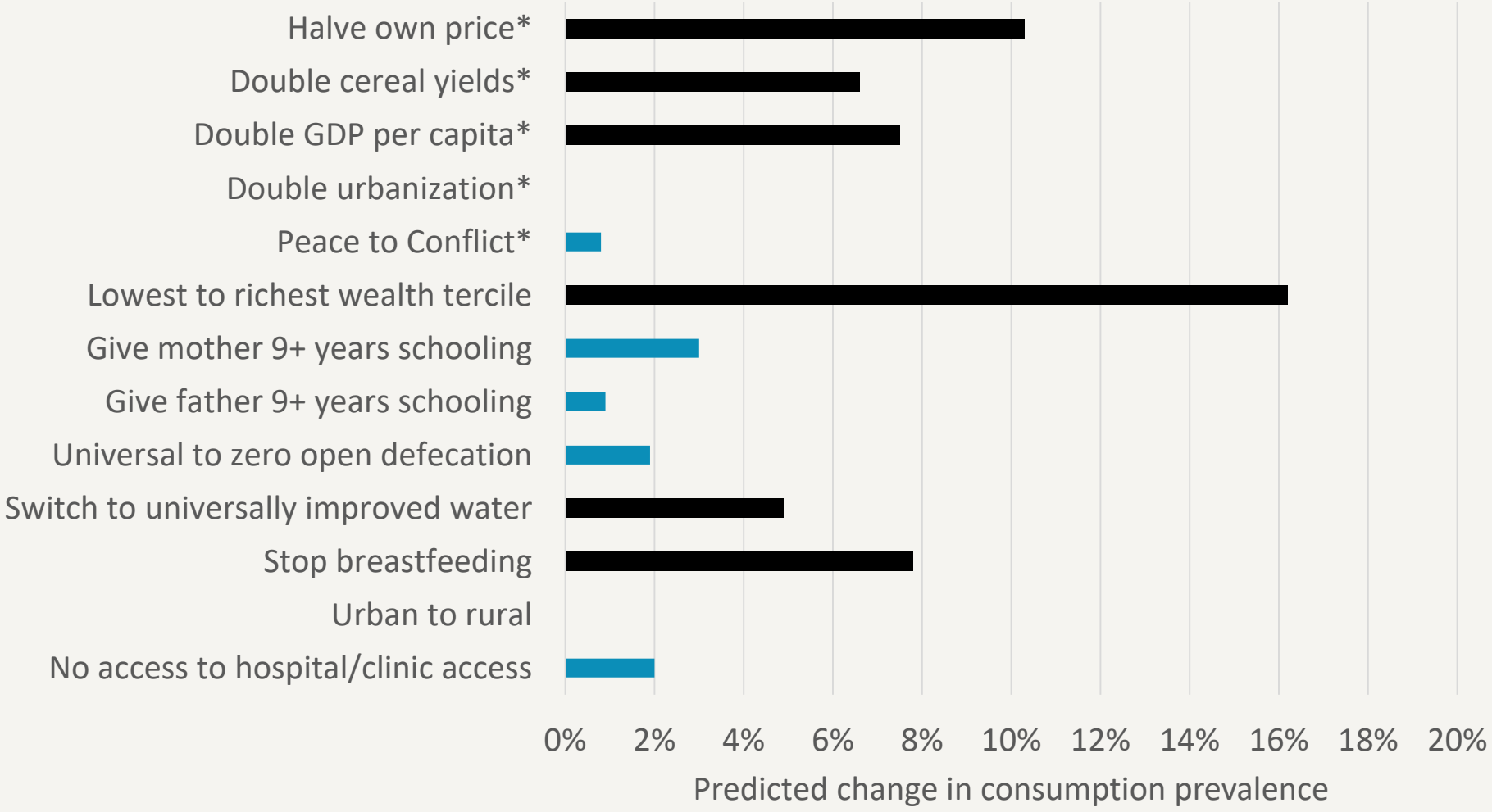
| | Roots & tubers | Legumes | Cow's milk, fresh | Cow's milk, Proc. | Chicken eggs | Meat | Fish | Fortified baby cereal |
|---|---|---|---|---|---|---|---|---|
| High income countries | 1.6 | 1.2 | 3.2 | 2.2 | 3.0 | 2.0 | 4.3 | 5.0 |
| Latin America & Caribbean | 1.2 | 2.2 | 3.9 | 3.0 | 4.9 | 3.2 | 3.4 | 9.6 |
| North Africa & Western Asia | 2.1 | 2.1 | 10.1 | 3.1 | 6.1 | 6.2 | 6.0 | 16.1 |
| South, Central & South-East Asia | 1.5 | 2.0 | 7.8 | 3.8 | 6.2 | 6.5 | 5.3 | 16.4 |
| Western & Central Africa | 1.0 | | 16.5 | 4.0 | 9.9 | 5.3 | 5.0 | 23.4 |
| Eastern & Southern Africa | 1.7 | | 13.9 | 5.8 | 9.1 | 5.6 | 6.1 | 18.6 |

# Constraints to ASF consumption: Eggs

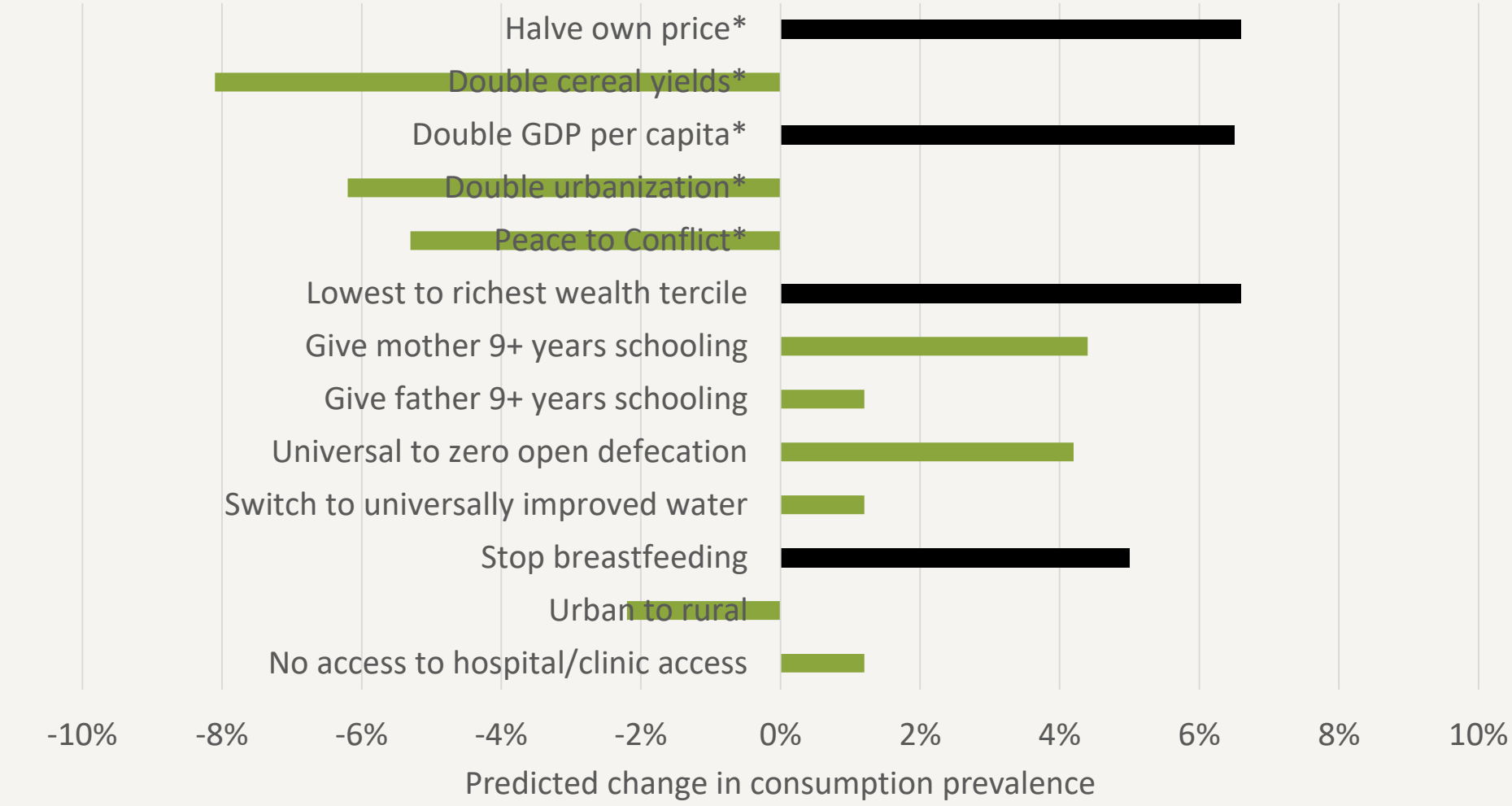
**Fig 1. Predictors of 24-hr recall egg consumption among kids 6-23m**



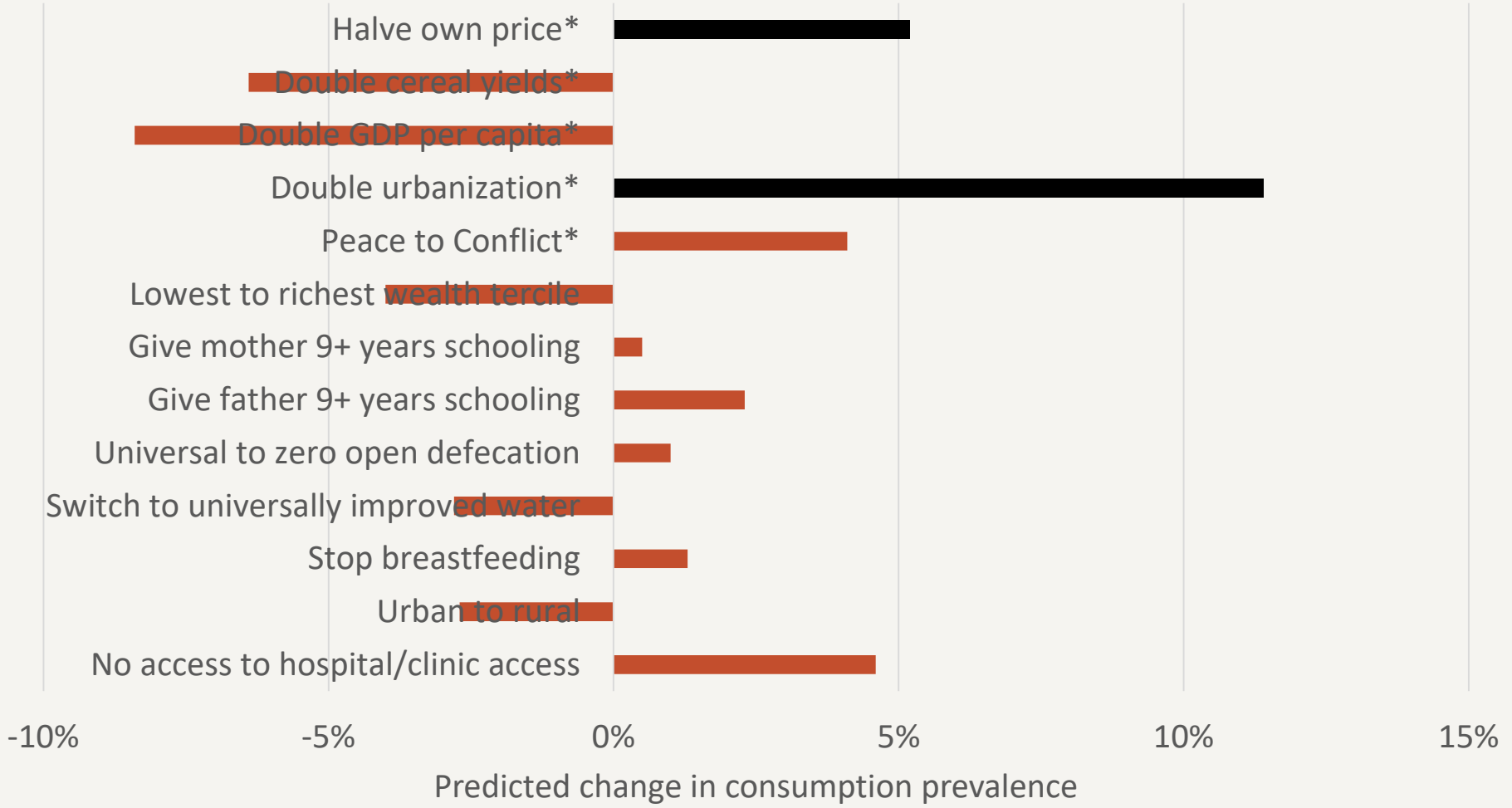
# Constraints to ASF consumption: Dairy



# Constraints to ASF consumption: Meat



# Constraints to ASF consumption: Fish

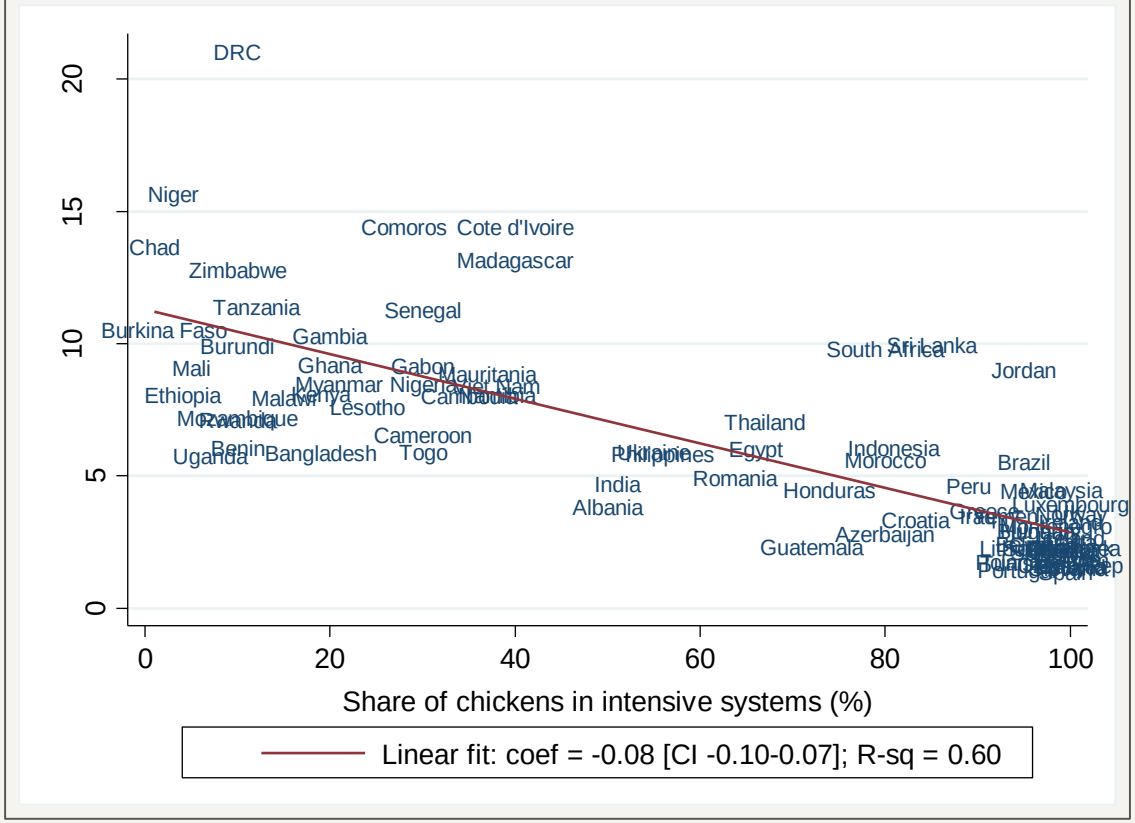


# Constraints to dietary diversification

- Poor people face a double economic burden: poverty & high prices
- Why are nutrient-rich foods so expensive?

- Highly perishable; difficult to trade long distance
- Limited trade means relative prices largely set by local productivity levels
- Productivity is low in poor countries: e.g. backyard poultry very widespread, but children don't eat eggs
- Egg prices are lower when poultry is commercialized

**F1. Egg prices & share of chickens in intensive systems**



# Conclusions

- Nutritionists have long emphasized important nutrient properties of ASFs, including renewed interest in protein quality
- Only limited evidence linking ASF consumption to improved growth outcomes, and little work exploring constraints to ASF consumption
- In this paper we find:
  1. **ASF consumption still low in Africa & Asia:** ~50% of kids with 1+ ASFs
  2. **Diverse ASF consumption patterns**: fish strikingly important in many countries where dairy is less important; meat/egg consumption low
  3. **ASF consumption strongly associated with growth**: consuming a diverse array of ASFs seems more beneficial than any single ASF
  4. **ASFs are very expensive relative to cereals:** especially true for fresh milk and eggs; fish and meat relatively cheap in some places
  5. **Multiple constraints to ASF consumption:** High prices are a constraint for all ASFs, and wealth often a constraint (especially for diary)

# Conclusions

**What explains high prices of most ASFs?**

- Perishability/tradability are major factors:
- Eggs/fresh milk hard to transport without efficient value chains (Totally different from cereals, pulses, roots, tubers, etc)
- Inability to import perishable foods means their prices are set by local productivity levels: poor countries are unproductive!!
- In contrast, flesh foods can be moved as live animals, salted, chilled

**Sector-specific constraints**

- Dairy: livestock diseases & climate are major constraints; why don't Africans consume more powdered milk?
- Eggs: Scale economies are huge, but poor countries are beset by backyard systems that are attractive because of low inputs required; but low input means low out; also potentially significant health risks

# Conclusions

**Policy implications**

1. Focus on dietary diversification, but ensure that it includes a ***strong emphasis on ASFs***, including multiple ASFs
2. Knowledge constraints may still be important, but critical to use production, value chain and trade policies to ***reduce ASF prices***
3. Factor in ***environmental implications***: vast differences in GHG emissions from different types of ASF production (chicken & fish)
4. Factor in ***human health externalities*:** livestock production has zoonotic disease risks, including enteric and pulmonary infections