HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

Household technology and human development in low and middle-income countries

Omar Karlsson, Takemi Fellow, Harvard T.H. Chan School of Public Health
okarlsson@hsph.harvard.edu

THE TAKEMI PROGRAM IN INTERNATIONAL HEALTH

Overview

1. Background
   - Human development
   - Household technology
   - Education in low- and middle-income countries (LMICs)
   - Child health outcomes in LMICs
   - Household technology in LMICs
2. Theory
   - Proximate determinants framework
   - Time-use
   - Effect heterogeneity
3. Previous research
4. Research questions
5. Data and Methods
6. Preliminary results
   - Assets and amenities in India: an exploratory study
   - Access to electricity and child health in 22 LMICs
7. Conclusions
8. Contribution

Human development

- Child health and education
- Early life and childhood are pivotal periods for capability formation
  - Sensitivity to adverse exposures
  - First 1,000 days of life (Barker)
    - Cognitive development
    - Future health
  - ‘Skills’ beget ‘skills’ (Heckman)
    - Dynamic complementarities and self-productivity of skills
    - High returns (in capabilities and human capital) to early investments
    - E.g., healthier children are more likely to attend and perform better in school

Human development

- Important capabilities
  - Health
    - Nutrition
    - Infections (e.g., causing diarrhea)
    - Cumulative exposures (e.g., reflected in height-for-age)
    - Child mortality
  - Basic education
    - School attendance
    - Performance

Household technology

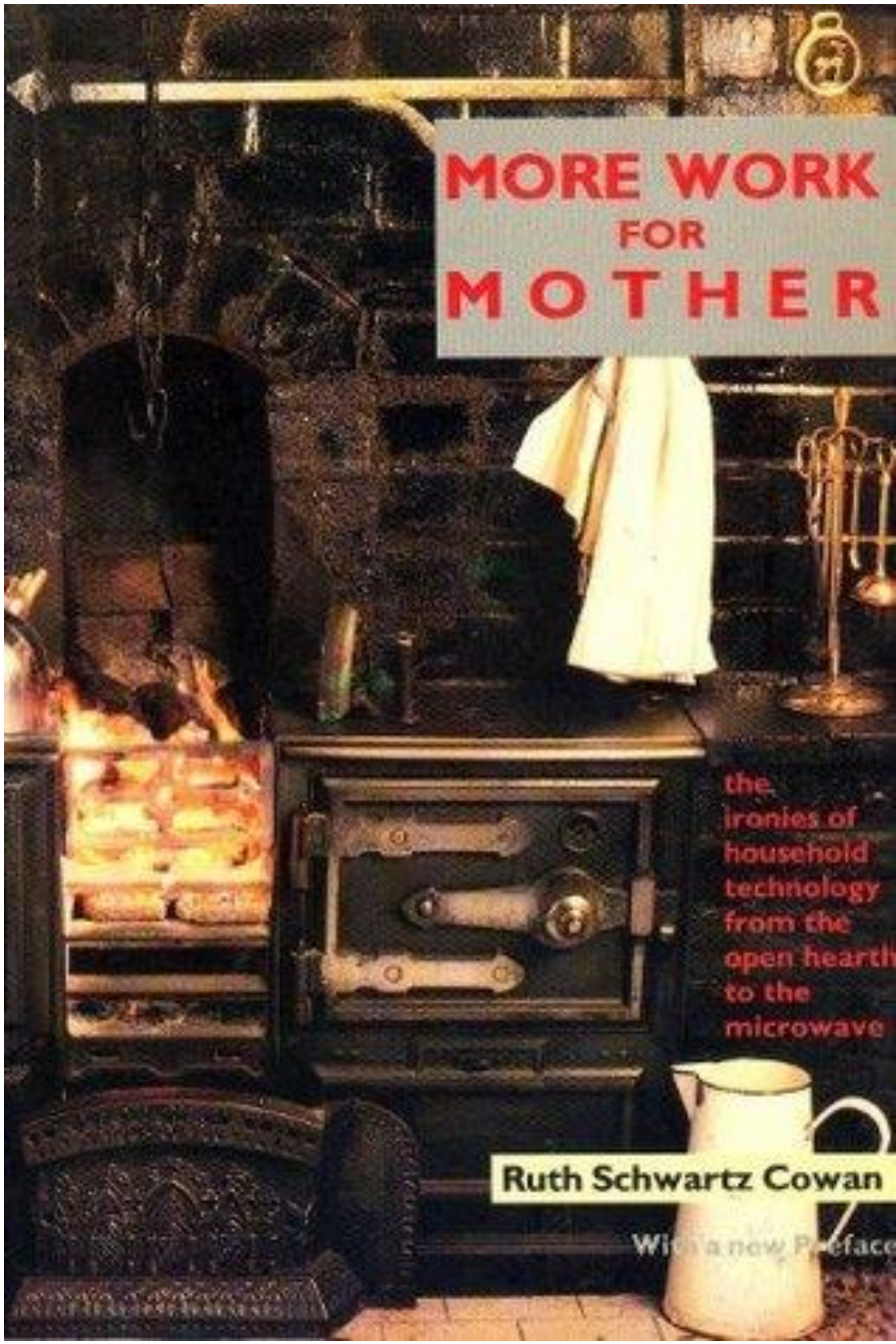
- Assets and amenities
  - **Electricity**
  - **Home appliances**
  - Piped water
  - Toilet facilities
  - Telecommunication
  - Transportation

Household technology

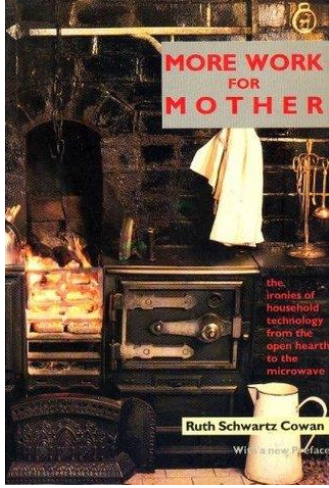
- Allows households to substitute capital for labor
- Increase efficiency of household work
- Improves quality of household work
  - E.g., hygiene, less food contamination, better nutrition
- Child health is produced domestically

Household technology

- Transformative for societies
- Increased efficiency
  - Better quality rather than less time spent on housework
- Increased standards
  - Germ-theory
  - Nutrition science
- Diffusion of knowledge
  - Advertisers, magazine articles, “sanitary missionaries”



Household technology



- Social pressure
  - "Authority of science was combined with fear, guilt, and old-fashioned moral authority"
  - "[advertisers] spread the message that a woman who did not purchase the growing array of consumer products was jeopardizing her family"
  - "Cleanliness is next to Godliness"
  - "Microbes were an invisible, omnipresent evil agent, a live monster threatening with infinite malice to attack the most vulnerable members of society"
  - Delayed widespread labor-force participation of married women

The Economist

International

May 31st 2014 edition ›

Fridge ownership

Cool developments

How chilled food is changing lives

"They improve health by cutting food contamination and allowing families to add high-protein foods to a diet of grains and vegetables. In places where fortified cereals are unavailable, the World Health Organisation recommends that toddlers eat food from animal sources daily. Many poor mothers could afford to buy meat relatively often, but cannot find cuts small enough; with fridges they can store larger portions and use only a bit at a time."

Child education in LMICs

- Low-income countries and [middle-income countries]
  - Primary
    - 67% and [92%] complete primary school
    - 81% and [90%] net-primary school enrolment
  - Secondary
    - 34% and [68%] net-secondary school enrollment
  - Obstacles
    - Access (E.g., costs, distance)
    - Poor quality (e.g., study material, infrastructure)
    - **Child labor**
    - **Poor health and nutrition**

Child health in LMICs

- Low-income countries and [middle-income countries]
  - 35% and [22%] stunted physical growth
    - Indicative of chronic undernutrition and repeated infections
    - Long term negative consequences for human development
  - 68 and [36] under-5 deaths per 1,000 live births
- *47* countries not on track to achieve the SDGs on under-5 mortality
  - Mostly in sub-Saharan Africa

Child health in LMICs

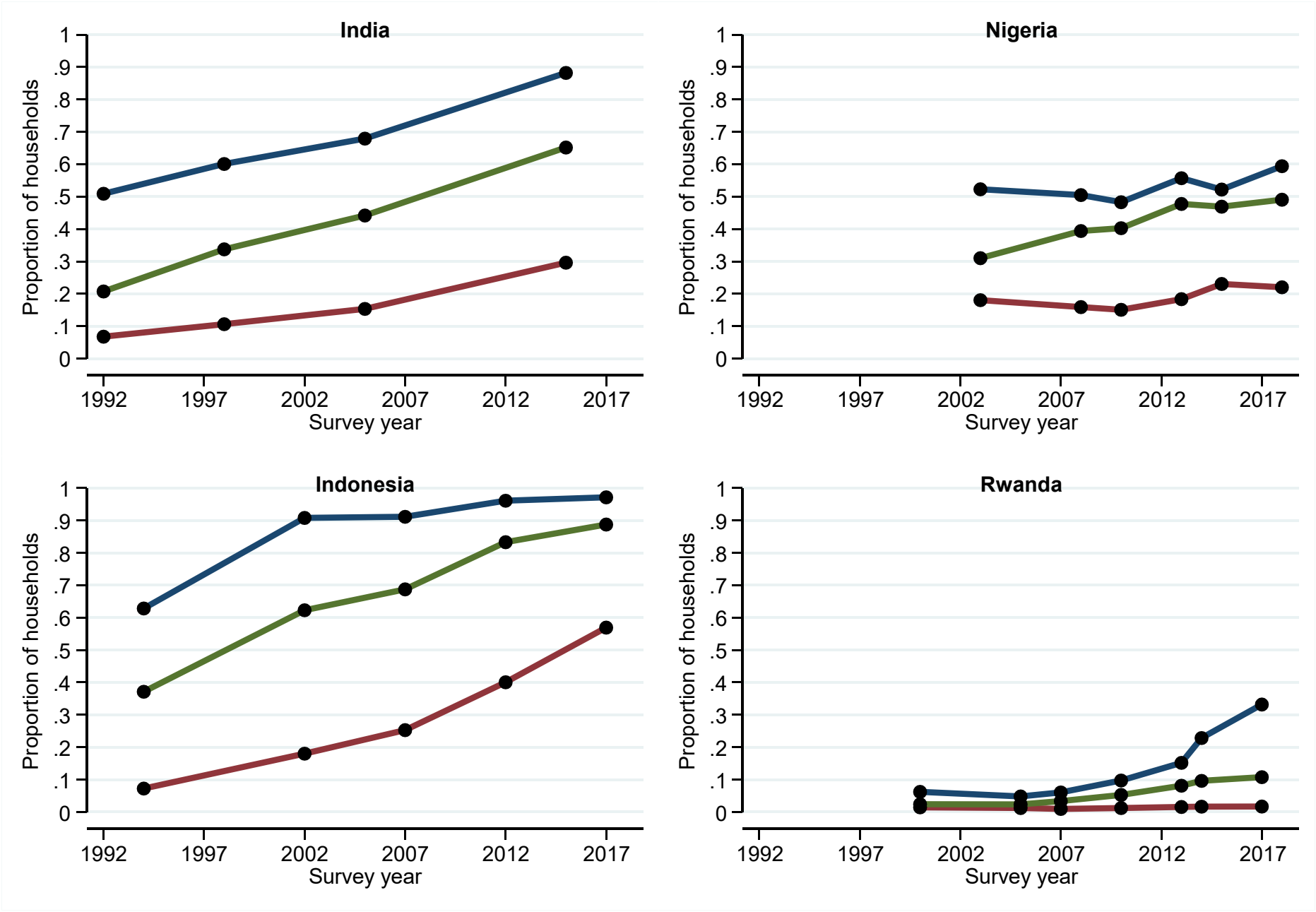
- Leading causes of poor child health
  - Pneumonia (13% of deaths)
  - Diarrhea (9% of deaths)
  - Injury (5.5% of deaths)
  - Malaria (5% of deaths)
    - Deaths are concentrated in sub-Saharan Africa
  - Undernutrition an important causal component
- Poverty an underlying cause

Child health in LMICs

- Links between poverty, economic growth, and child health
  - Water and sanitation (Preston, Deaton)
  - Health care (Preston , Deaton)
  - Nutrition (McKeown, Fogel)
  - Education
  - Stronger links in the past (Preston)
    - Low cost interventions caused much improvements after 1950
- Household technology
  - Largely unexplored link between poverty, economic growth, and child health
  - New avenues for improvements

Household technology in LMICs

- Ownership of durable consumer goods and access to amenities in low income and [middle income] countries
  - 59% and [8%] do not have access to electricity
  - 88% and [43%] do not use clean cooking fuel or technology
  - 70% and [27%] do not have basic sanitation services
  - 43% and [9%] do not have basic drinking water services
- From recent household surveys
  - 73% of households do not own a refrigerator


India
Nigeria
Indonesia
Rwanda
Proportion of households
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
1992
1997
2002
2007
2012
2017
Survey year
Electricity
Refrigerator
Television

Direct effects: Proximate determinants framework

- Mosley, W. H., & Chen, L. C. (1984). An analytical framework for the study of child survival in developing countries. *Population and Development Review*, 25–45.
- Linking social end economic determinants to child health outcomes
- Social and economic determinants affect child health through proximate determinants
- Proximate determinants: 5 broad categories
  - **Environmental contaminants (exposure to pathogens)**
  - **Nutrient deficiencies**
  - Injuries
  - Personal illness control (curative and preventative treatments)
  - Maternal factors (age, parity, and birth interval)

Direct effects: Proximate determinants framework

- Food storage and preparation
  - Refrigerators
    - Reduced food contamination (environmental contaminants)
    - High-protein foods (nutrition)
  - Electric cooking equipment
    - Increased nutrient value (nutrition)
    - Reduced indoor air pollution (environmental contaminants)
  - Table for preparing food (rather than floor)
- Water, sanitation, and hygiene
  - Water-borne infections, fecal germs (environmental contaminants)
  - Hygienic living quarters (environmental contaminants)
- Effects on child education
  - Well-nourished and healthy children are more likely to attend and perform better in school

Indirect effects: Time-use

- Becker, G. S. (1965). A Theory of the Allocation of Time. *The Economic Journal*, 493–517.
- 50 hours a week on household work without modern appliances
  - 15-30 extra hours with young children
- Assets and amenities have the potential to reduce time spent on housework
- Economic activities outside the home
  - Augments household incomes
  - Especially for women
  - Resources in the hands of women may be favorable for child health
- Effects on child education
  - Reduced need for employing children within the home

Time-use effects on the proximate determinants

- Increased efficiency of household work with home appliances did not reduce time spent on household work but improved the quality
  - E.g., improved hygiene
- Time important for ensuring health of children
  - Cheap but time consuming
    - Oral rehydration therapy (illness control)
    - Travel and wait times for public health clinics (illness control)
    - Household hygiene (environmental contamination)
    - Direct supervision of children (e.g., injuries)

Effect heterogeneity

- Other social, economic, and behavioral factors need to be in place, e.g.:
  - Food distribution
    - To increase the utility of a refrigerator
  - Climate
    - Food contamination more likely when food is stored at high ambient temperature and in wet-climates
  - Labor market
    - To augment incomes
  - Knowledge
    - About importance of proper food storage and household hygiene

Previous research

- Well established determinants of child health
  - Water, sanitation, and hygiene
  - Clean cooking fuel
  - Mixed results from randomized controlled trials
- Some evidence
  - Access to electricity on child health
    - E.g., access to electricity had a large causal effects on infant mortality in the U.S., 1930 – 1960 (Lewis, 2018)
  - Ownership of washing machines
    - Increased school attendance for girls in China (Kerr, 2019)

Previous research

- Household technology and other measures
  - Access to electricity (mixed evidence)
    - Education, fertility, income, adult health
  - Time savings (mixed evidence)
    - Used for improved quality of household production rather than reduce time spent on it (Mokyr, 1998)
  - Labor force participation (mixed evidence)
    - Evidence on effects of female labor force participation on child health are also mixed

Research questions

- **RQ1. Does access to electricity improve child health and education?**
- **RQ2. Do household goods used for food preparation and storage improve nutrition and reduce infections in children under five years old?**
- RQ3. Do household goods used for improving hygiene, sanitation, and clean water improve nutrition and reduce infections in children under five years old?
- RQ4. Do improved nutrition and reduced infections from household technology also increase school attendance and improve performance?
- RQ5. Does household technology improve child health and education through reduced workload from household work?
- RQ6. What has been the role of household technology in the relationship between economic growth and improvements in child health and education over the past century?

Data and Methods

- Data
  - Demographic and Health Surveys (DHS)
    - Large scale household surveys
    - Detailed health data on children under five years old
    - Detailed data on assets and amenities
    - Conducted roughly every five years in multiple countries since 1990s
    - Standardized for testing general relationships in multiple countries
    - Geocoded villages and neighborhoods
  - Living Standard and Measurement Studies
    - Longitudinal panel data from multiple countries
    - More detailed to test specific mechanisms
  - Supplemented with data on electricity distribution and generation

Data and Methods

- Methods
  - Quasi-experimental designs
    - Difference-in-difference
      - Long lasting power outages
      - Expansion of power grids
    - Instrumental variable
      - Distance to power stations
  - Matching methods
    - To create highly comparable treatment and control groups

Results: Assets and amenities in India

- Karlsson, O., Kim, R., Joe, W. and Subramanian, S.V., 2020. The relationship of household assets and amenities with child health outcomes: An exploratory cross-sectional study in India 2015–2016. SSM-Population Health, 10, p.100513.
- An exploratory study
- India 2015-16 Demographic and Health Survey
- Which assets and amenities have a residual association with a range of child health outcomes?
  - After controlling for other measures of SES, demographic factors, and unobserved village/neighborhood (PSU) effects
  - Outcomes: Stunting, underweight, wasting, anemia, mortality, diarrhea

Results: Assets and amenities in India

- All assets and amenities used to construct the widely used DHS household wealth index
  - In the absence of income and expenditure data, wealth indices are often used to measure economic status
  - Principal component analysis used to derive weights for each asset and amenity to create a single summary measure of household wealth
  - Some assets and amenities used in the wealth index may be important exposures

a) Water and toilet facilities

Water pump

Type of toilet facility

Type of water access

b) Food storage and preparation

Refrigerator

Pressure cooker

Type of cooking fuel

c) Housing quality

Number of residents per bedroom

Main material of the floor

Main material of the roof

Main material of the walls

d) Other consumer goods

Radio

Bicycle

Motorcycle/scooter

Car/truck

Telephone (land-line)

Mobile telephone

Watch

Mattress

Chair

Cot/bed

Table

Electric fan

Black and white television

Color television

Sewing machine

Computer

Air conditioner/cooler

Washing machine

e) Other items

Household has staff

Household has a bank account

Household has access to electricity

Animal-drawn cart

Land usable for agriculture

Household has access to internet

Thresher

Tractor

Household owns a house

Results: Assets and amenities in India

- Consistent association for:
  - Appliances for storing and preparing food
  - Water and sanitation
    - Particularly strong for mortality
  - Household building material
- No consistent association for:
  - Most consumer goods (washing machine, radio, tv etc.)
  - Amenities (electricity, bank account, internet)
- Absence of association with electricity surprising
  - 88% of households have electricity
  - Not much variation in access within villages/neighborhoods

Preliminary results: Access to electricity and child health in 22 LMICs

- DHS household surveys from 22 countries including 135,052 children under five
  - Conducted after 2010
  - At least 20% of households without electricity
- Health outcome: Height-for-age z-score of children under-5 years old
  - Indicative of chronic undernutrition and repeated infections
- OLS and 2SLS estimation of child health on household access to electricity
  - Access to electricity likely to be endogenous with regards to child health as it signals economic development more broadly

Preliminary results: Access to electricity and child health in 22 LMICs

- Distance to power-station an instrument for electricity access
  - Lewis (2019): a study on the U.S. 1930 - 1960
  - Comprehensive data on power stations compiled by KTH Royal Institute of Technology
  - Distance correlated with access to electricity
  - Exclusion restriction
    - Distance can only be correlated with child health trough electricity access
    - Location of power-stations determined by environmental factors which are unlikely to be correlated with child health
    - Past stunting and electricity access not correlated with opening of a new powerplant (within countries/sub-regions)
    - Building a power station requires a lot of labor which may be problematic for the exclusion restriction

Preliminary results: Access to electricity and child health in 22 LMICs

- Gelbach (2016) decomposition
  - Statistical impact of covariates on the coefficient for electricity
  - Quantifies how much of the difference in height-for-age between households with electricity and without electricity is accounted for by each added covariates
    - Owning a refrigerator
    - Cooking with electricity
    - Owning a radio
    - Owning a television
    - Owning a mobile telephone
    - Household wealth
    - Maternal education
    - Number of siblings

	Mean	95% CI
Height-for-age z-score	-1.43	-1.44, -1.42
Household has electricity	0.35	0.35, 0.36
Distance to power station (km)	156.4	155.51, 157.29
Number of siblings	2.87	2.85, 2.88
Child is female	0.5	0.49, 0.5
Age (months)	28.79	28.67, 28.9
Child is twin	0.03	0.03, 0.03
Household is Rural	0.71	0.71, 0.71
Household owns a refrigerator	0.12	0.12, 0.12
Household cooks with electricity	0.03	0.03, 0.03
Household owns a TV	0.32	0.32, 0.32
Household owns a radio	0.46	0.45, 0.46
Household owns a mobile telephone	0.74	0.74, 0.74
Mother's education (years)	4.45	4.43, 4.48
Household wealth index (z-score)	-0.09	-0.1, -0.09

Estimates are weighted

	Height-for-age z-score (n=135,052)			
	OLS		2SLS	
	Coefficient	p-value	Coefficient	p-value
Basic models	0.22	<0.01	0.56	<0.01
Full models	-0.05	0.02	-0.07	0.91
	Decomposition of covariates added to full models			
Owns a refrigerator	0.02 [6%]	<0.01	0.05 [9%]	0.01
Cooks with electricity	-0.01 [-2%]	0.04	-0.02 [-3%]	0.20
Owns a radio	<0.01 [1%]	0.16	0.01 [1%]	0.18
Owns a TV	-0.01 [-2%]	0.61	-0.06 [-11%]	0.60
Owns a mobile phone	0.02 [6%]	<0.01	0.05 [10%]	<0.01
Household wealth	0.22 [75%]	<0.01	0.42 [80%]	0.16
Number of siblings	-0.01 [-3%]	<0.01	-0.02 [-4%]	<0.01
Maternal education	0.05 [19%]	<0.01	0.10 [18%]	<0.01
Partial F-statistic			172 [28]	

Partial F-statistic is for basic and [full] first stage regressions. Covariates in basic regressions: sub-region, age, sex, twin. Estimates are weighted and p-values adjusted for clustering.

Conclusions

- Well established determinants, type of toilet facilities and water access, have the most consistent association with child health in India
- Assets used for cooking and storing food also show a consistent, although weaker association with child health in India
- Strong effects of electricity on child health

Contribution

- Determine unexplored links between economic growth and child health
- Determine causality
- Investigate effect heterogeneity
- Recommending financing of specific assets and amenities which improve child health

Omar Karlsson

okarlsson@hsph.harvard.edu