Health Impacts of Household Air Pollution in the PAHO Region

What is to be done?

Kirk R. Smith
Professor of Global Environmental Health
University of California, Berkeley
Problems due to household burning of solid fuels

- Poor use of natural resources
- Threat to natural environment
- Inefficient use of women’s time
- Climate impacts

But, here, I only focus on health
What has been done—#1

• Wait for development to work.
• Bottom line
  – Percent using solid fuel slowly declines with development alone (no special policies)
  – But not always number of people exposed
  – But can decline much faster with targeted clean fuel policies
Increasing Prosperity and Development

Decreasing Household Air Pollution

Very Low Income 200 million

Low Income 400 million

Middle Income 400 million

High Income 200 million

Ag res - 15%

Non-solids fuels

Solid Fuels

Wood - 49%

Elec < 1%

PNG < 1%

LPG - 30%
Low- and Middle-Income Countries
Cooking in PAHO LMICs 1990-2010

• Solid fuel users in region went from 120 million to 80 million (27% to 14% usage)
• Decline was due to Argentina, Ecuador, Uruguay, & Venezuela going to near zero usage from a total of nearly 20%
• And Belize, Brazil, Costa Rica, Chile, Guyana, & Jamaica cut usage by 3x
• Although Columbia, El Salvador, Mexico, & Peru only had slow declines in users
History, cont.

- Countries with about the same number using solid fuels after 30 years
  - Honduras
  - Nicaragua
  - Panama

- Countries with more users after 30 years
  - Cuba
  - Guatemala
  - Haiti
  - Paraguay
What has been done-#2

- Many hundreds of “improved” biomass stove programs over ~40 years.
- Earliest in Guatemala – Lorena in 1970s
- Major national programs in China and India in the 1980s covering ~200 million households in all
- Peru, Mexico, Nepal and other countries today
- Hundreds of NGOs, big and small, promoting stoves around the world over the decades
- Hundreds of stove models
Diversity of improved cook stoves
Figure S29. PM$_{2.5}$ Emission Rate (per Time)

Best lab performance with dry wood - ~8x IAQG

Jetter et al., EST, 2012
RESPIRE
Impact on pneumonia up to 18 months of age

Traditional open 3-stone fire: kitchen 48-hour PM$_{2.5}$ levels of 600 - 1000 μg/m$^3$

WHO AQG = 10-35 μg/m$^3$

Chimney woodstove, locally made and popular with households
Effect of Chimney Stove On Kitchen CO Levels

285 48-h Measurements

Factor of ~10 less

Smith, et al, 2010

Guatemala RCT: Kitchen Concentrations

Kitchen CO concentration (ppm)

Control – open fire

Intervention – Chimney Stove

Months

Smith, et al, 2010
Effect of Chimney Stove On Infant Exposures - 2x less

Smith, et al, 2010

1888 48-h measurements
~50% reduction in exposure of babies

Chimney stove did not protect all babies
heart of the hearth

LONG-LASTING LOW EMISSIONS COMBUSTION UNIT
Corazón de la casa (hogar)

Multi-million Dollar Global Innovation Prize for a Truly Clean Biomass Combustion “Engine” for Household Stoves

Bottom Line - #2

• The cleanest stove models have been disseminated to only a few thousand households in the region

• And, as yet, no biomass stove in the world comes close to the boundary – is clean enough to be truly health protective in household use

• Perhaps they can be clean enough, but much more work is needed
Increasing Prosperity and Development

Decreasing Household Air Pollution

Very Low Income
200 million

Low Income
400 million

Middle Income
400 million

High Income
200 million

Crop Waste Dung
Solid Fuels

Dung
Non-solid fuels

Wood

Liquefied Petroleum Gas

Electricity
Natural Gas

Continue to try to Make the Available Clean
New Paradigms

Paradigm #1

Making the clean available
From ~4% of DALYs in 1990

~1.5% of DALYs today

How?
Ecuador

Not in the top 15 risks
Costa Rica

Not in the top 15 risks
The Brazil Story

The saturation levels of LPG (% total HH)
The Brazil Story

Evolution of LPG demand: total and average per capita consumption (1990=100)

Total LPG consumption

Ends LPG uniform pricing, subsidies and government control (partial and gradual)

Oil sector de-regulation

Graph showing the evolution of LPG demand with time.
Porous radiant burners → Porous medium combustion

Advantages

✓ Flameless combustion
✓ Based on renewable energy sources
✓ More efficient heat transfer
✓ Suitable for low BTU value fuels
✓ Can reduce smoke and pollution

Up to 25% more efficient
Increasing Prosperity and Development

Decreasing Household Air Pollution

Very Low Income 200 million
Low Income 400 million
Middle Income 400 million
High Income 200 million

Try harder to Make the Clean Available

Household Energy Ladder

Non-solid fuels
Wood
Solid Fuels

Crop Waste Dung

Liquefied Petroleum Gas
Electricity
Natural Gas
Paradigm #2
Stepping out of the box
If you don’t need your father’s land line for a phone, why your mother’s stove?

- Electrification is an essential human need – brings many social and economic benefits
- Electrification also allows a wide range of highly efficient cooking devices
- Every time a switch is flicked, instead of a match, it is good for health
What is an induction cookstove?

- Electric, yes, but entirely different technology from traditional electric stoves
- High frequency magnetic field induces heat in pot alone
- More efficient ~90% instead of ~60%
- Faster cooking ~1.5x
- Safer and cooler—surface is warm but does not burn or cause fires
- Long-lived, easy to clean
- Large economies of scale in manufacture like other electrical devices
Cooking with Induction
Safer – the stove does not get hot
Induction Cooktop Market in India 2012-2016

Published: March 2013
Infiniti Research Limited

35.4% per year growth predicted: 2012-2016

Factor of nearly five increase!

- Bajaj Electrical Ltd.
- Compton Greaves Ltd.
- Eurolux
- Glen Appliances Pvt. Ltd.
- Inalsa
- Jaipan Industries Ltd.
- Kenwood Ltd.
- Khaitan Electrical Ltd
- Morphy Richards
- Panasonic Corp.
- Phillips
- Preethi Kitchen Appliances, Ltd.
- Sunflame
- TTK Prestige Ltd.
- Usha International Ltd.
- Westinghouse
Flying off the shelves in China
Costs coming down dramatically

US $7.80 each (with warranty):
The cost of two coffee lattes

Ecuador has $250 million loan from Chinese Export Bank to begin to change out every stove in the country to induction
Increasing Prosperity and Development

Decreasing Household Air Pollution

Very Low Income 200 million

Low Income 400 million

Middle Income 400 million

High Income 200 million

Crop Waste Dung

Solid Fuels

Wood

Non-solid fuels

Liquefied Petroleum Gas

Natural Gas

Electric Induction

Household Energy Ladder
Paradigm #3: It takes a village

Gujarat, Feb Evening
Changing out one hearth at a time is not as effective as changing out whole villages

• Learned in sanitation programs years ago:
• Benefits:
  – Herd effect: both household and community benefits to clean fuels/stoves and latrines.
  – With community interventions, a new set of incentives and social pressures are possible.
  – More efficient provision of service
Smokeless Villages?

- Government of India has been promoting sanitation coverage to ensure better health and quality of life for people in rural India.
- In 2005, it launched an award-based Incentive Scheme for open-defecation-free villages,
- Same kind of “herd” effect operates for dirty combustion – need to not have offending material in places where people live
Paradigm #4: It is a health issue

• Not primarily an energy, climate, or employment issue
• Health sector finds the most effective solutions possible and makes them available
• Treats all the same: we do not have rural vaccines and urban vaccines
• Not stopped by taste, custom, poverty, special interests, or political correctness
• Not afraid of advanced tech that works
The health community expects proposed health Interventions

- To have systematic and phased evaluations of their laboratory and field efficacy and effectiveness – as with vaccines, drugs, bednets, latrines, etc.
- This must include rigorous monitoring: “You don’t get what you expect, but what you inspect” (No lográs lo que esperás, sino lo que inspeccionás)
- With cookstove/fuels, the best analogy is not a vaccine, but DOTS: directly observed therapy
Week Since Intervention

Duration of Philips Use (Hours)

Number of Stove Uses

- Traditional
- Philips
Week Since Intervention

Duration of Philips Use (Hours)

Number of Stove Uses

Traditional

Philips

0  5  10  15  20  25  30

-10  -5  0  5  10  15  20  25  30

Week Since Intervention

Number of Stove Uses

Traditional

Philips

0  5  10  15  20  25  30

-10  -5  0  5  10  15  20  25  30

Week Since Intervention

Duration of Philips Use (Hours)
We report data from two groups: traditional and Philips. Traditional uses are shown with red lines, while Philips uses are shown with teal lines. The graphs illustrate the number of stove uses and the duration of Philips use over time since the intervention.
Indian Ministry of Health
Air Pollution Task Force

• First Ministry of Health in world to treat AP as one of its major priorities and consider along with other risk factors in its mission

• First government agency in the world not to address AP by location, but by total exposure – a true health focus

• Thus, not indoor/household, not outdoor, but by what will give the most health benefit
Proposal for PAHO Region

• Workshop followed by publication
• Household Fuel Transitions for Health in Latin America
• Share histories, lessons learned, etc from nations have made transition
  – Brazil, Ecuador, Costa Rica, etc.
• And those wishing to do so
Paradigm Shifts

- Make the clean available, as well as make the available clean
- Embrace/enhance transformational leap-frog technologies
- Look for community solutions
- Enhance displacement of clean fuels from richer to poorer households
- Act recognizing that it is primarily a health issue and thus optimize on exposure reduction not renewability, local content, or climate
Increasing Prosperity and Development

Decreasing Household Air Pollution

Very Low Income
200 million

Low Income
400 million

Middle Income
400 million

High Income
200 million

Crop Waste Dung

Solid Fuels

Wood

Non-solid fuels

Liquefied Petroleum Gas

Natural Gas

Electricity

How do we help people move into this realm?

Smith/Pillarisetti, 2014